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SCIENCE

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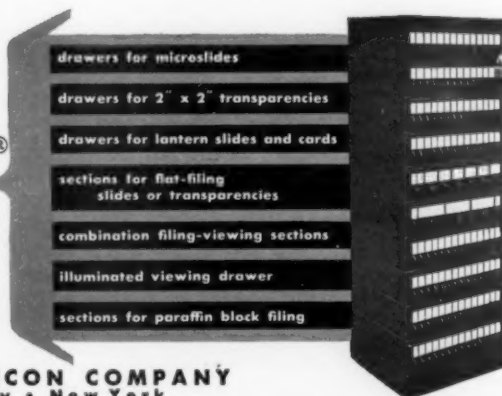


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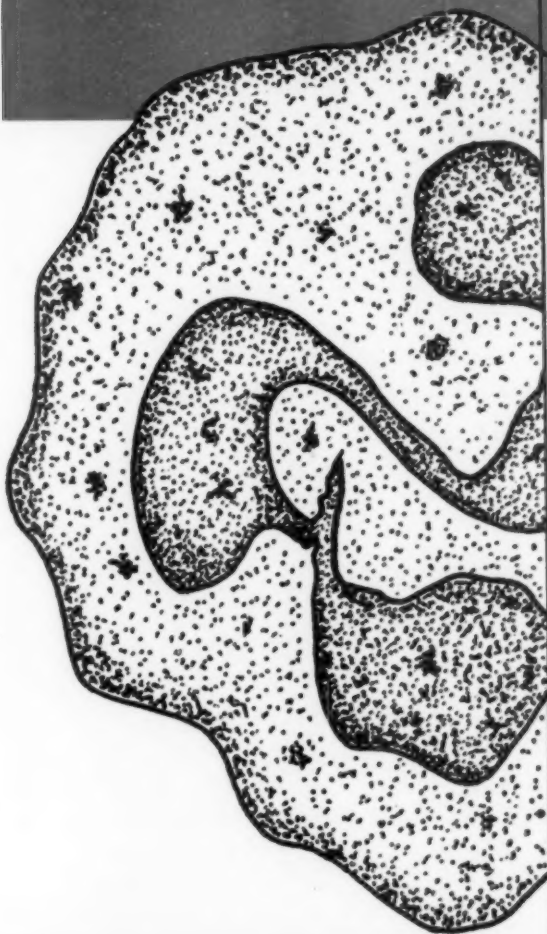


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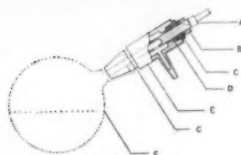
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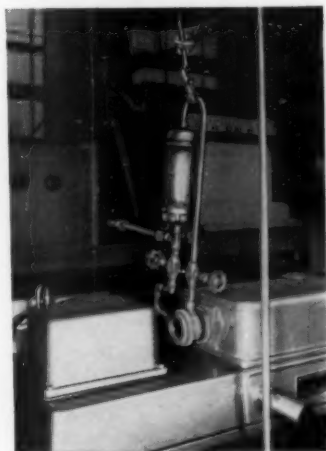
P-E Analytical News

Analyzing for Impurities in Liquid Chlorine

Estimating impurities in liquid chlorine is no picnic. Although contaminants are present in only a few parts per million, it's important for commercial chlorine makers to know how much and of what.

The analytical obstacles are enough to make the staunchest chemist blanch. Several liters of sample are required. Conventional analytical methods eat up loads of time. And if you use the most reliable method, distillation, you may wind up with a different impurity than the one with which you started.

But recently researcher A. W. Cross of the Central Research Laboratories, Canadian Industries, Limited has worked up an infrared analytical procedure — and now, with an assist, we are proud to say, from Perkin-Elmer, infrared analysis is eminently practical for routine commercial estimation of liquid chlorine impurities.



It seems that liquid chlorine is extremely transparent to infrared radiation. Which means you can use a cell path-length some 2000 times greater than is usual for most organic liquids. And long path length means high sensitivity to absorbing substances — on the order of a few ppm which is just what we're shooting for.

The special long path cell, designed here at P-E, is fitted to a stainless steel reservoir and needle valve system. This makes it possible to fill the cell with liquid chlorine directly from an inverted commercial cylinder. When filled, the reservoir and cell are supported in front of the business end

of a Perkin-Elmer Model 12-C single beam spectrometer, with a calcium fluoride prism. Calcium fluoride prisms give higher resolution than rock salt, and high resolution is a *sine qua non* in this type of analysis.

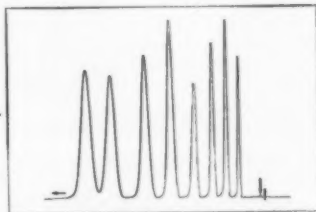
Quan and Qual Made Easy!

Awhile back P-E heard rumors that many chemists, asked to analyze particularly stubborn mixtures of gases or volatile liquids, become prone in a short time to aspirin addiction in its more severe forms. They complain of long, hard labor operating distillation columns or mass spectrometers, with only fair results. And they feel guilty using expensive equipment and giving little return on the investment.

Now at that time P-E was working with gas chromatography, a perfect solution for this very problem. The Vapor Fractometer was the result. This new tool, for analyzing gases and volatile liquids boiling below 300°C, takes advantage of the different affinities which materials have for one another to separate a mixture into its component parts.

Both equipment and analytical procedures are extremely simple, yet results in most cases equal or surpass those obtained from other methods. Fast, clean separations are made, and sensitivity of the detector plus recorder makes accurate quantitative determinations a breeze. Yet the Vapor Fractometer, with all these advantages, costs from 5 to 20 times less than old standby instruments.

Take LPG analysis, where most components cannot be cleanly separated by ordinary techniques. In operation, a metered sample of gas is blown through a column. The various components of the sample move through at different rates, depending on their affinity for the material in the column. Each arrives at the column end at a slightly different time to pass through a detector.



In a few minutes a series of peaks appears on a recorder, the first for the fastest moving component, and

so on down the line. Area under each peak is proportional to the amount of the component present in the mixture. Analysis shown took 23 minutes. Not only are compounds separated cleanly, but perfect shape of recorder bands makes quantitative analysis very accurate.

We'd be glad to work out applications to particular problems with those chemists who prefer the quick, easy approach, and those management men who hate to spend unnecessarily.

"NMR" — A New Analytical Tool

The phrase "Nuclear Magnetic Resonance" probably sounds completely foreign to the average chemist today, but it may well be in common usage in the laboratory of tomorrow. This recently discovered phenomenon has the look of a powerful new analytical tool. Essentially, this is it:

Most atomic nuclei behave as if they were spinning about an axis like tops, and seem to have small magnets parallel to the magnetic field. For a given magnetic field, the frequency of resonance for each isotope is a discrete value. The ratio of the magnet strength or magnetic moment value to spin value for a given nucleus, the "gyro magnetic ratio," is a constant. Since these ratios are different for different nuclei, the gyro magnetic ratio provides a means for identifying nuclei.

If a group of nuclei are placed in a magnetic field, they will tend to line up according to the specific orientations (spins) permitted them. If, in addition, a varying r.f. signal of the correct frequency is applied, the nuclei will precess. In essence, the nuclei resonate at this frequency and, in so doing, absorb some of the r.f. energy. Resonance frequency for a given nucleus is a function of strength of magnetic field and the gyromagnetic ratio of the nuclei involved.

In its simplest form, then, a nuclear magnetic spectrometer consists of a magnet, an r.f. generator, a simple coil and r.f. detector. A plot of r.f. energy absorption versus frequency constitutes a nuclear magnetic resonance spectrum.

P-E has set up a subsidiary to develop instruments based on this phenomenon. Now available: a broad band spectrometer and a magnetic field control system. Available soon: a fluxmeter and a high resolution spectrometer.

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We'll be glad to send you more information on any of these items. Or to put you on the mailing list for **INSTRUMENT NEWS**, a quarterly published by P-E to further research, material analysis and production through electro-optical instrumentation.

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The Orthophot

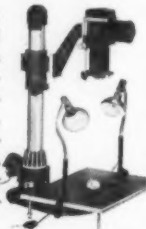
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Accessory units not shown include microprojection viewer with 8" x 8" vertical ground glass, alternative electronic exposure meters approximately 20 and 2000 times as sensitive as standard commercial types, and bellows-extension adapters to increase magnification or establish fixed ratios.

This versatile equipment is supplied either in complete assemblies, or in separate sections to coordinate with existing laboratory facilities.

PHOTOGRAPHY OF GROSS OBJECTS

Object table, oblique extension arm, and standard photo lens convert the ORTHOPHOT for photographing of gross objects, photocopying of papers, drawings, etc. Special table used for trans-illumination, X-ray copying, etc.



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HIGH-POWER PHOTOMICROGRAPHY (50 - 2000 x)

ORTHOPHOT set up with standard compound microscope. Built-in, permanently aligned light source on the Koehler principle, with complete color and intensity controls. Detachable, precision reflex camera has SPLIT-MICRON focusing device.

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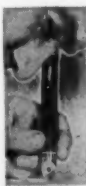
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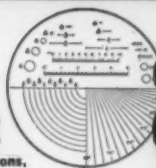
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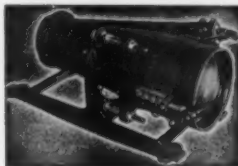
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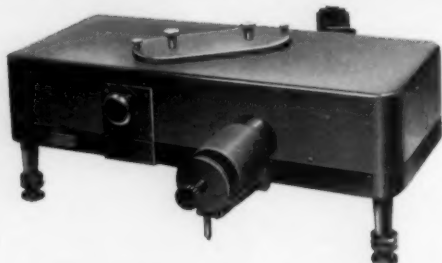
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Nature's Birthday

The first issue of *Nature* appeared on 4 November 1869. The publication date of this number of *Science* makes an appropriate occasion for sending birthday greetings to our sister journal, an occasion made more appropriate by the fact that a recent visit by *Nature's* editor L. J. F. Brimble, provided opportunity for discussions of the editorial and publishing problems and policies of the two journals.

Although there is never any mistake concerning *Nature's* distinguished reputation, in the United States it is sometimes mistakenly thought that *Nature* bears to the British Association for the Advancement of Science the same relationship that *Science* bears to the American Association for the Advancement of Science. That is not so. Since its founding, *Nature* has been owned and published by Macmillan and Company, Ltd. The original idea, however, came from a group of scientists, of whom Sir Norman Lockyer was the prime mover. In 1869, the same year in which he discovered the presence of helium in the sun, Lockyer began discussions of the founding of a general journal of science. His colleagues in the enterprise were a distinguished company. Among the scientists were Roscoe, Hooker, Tyndall, Huxley, and Darwin. Also involved were Archdeacon Hare, Dean Farrar, the headmaster of Harrow, and Charles Kingsley, the novelist and poet. Perhaps most important of all was Alexander Macmillan of the firm of Macmillan and Company. As a contribution to scientific progress, Macmillan and Company decided to publish *Nature*, and has continued to do so ever since, even though the journal ran at a financial loss for the first several decades.

Norman Lockyer, who gave *Nature* its name and its start, also gave it its character, for he was the first editor and remained in that post for 50 years. In 1919, Lockyer was succeeded by another astronomer, Sir Richard Gregory, who had been assistant editor for 26 years and who continued as editor until 1938. In 1938 Gregory was followed by the third, and present, editor, L. J. F. Brimble. Like Gregory before him, Brimble had served as assistant editor. *Nature* has been extremely fortunate both in the quality of its editors and in the continuity of editorial direction made possible by their long service.

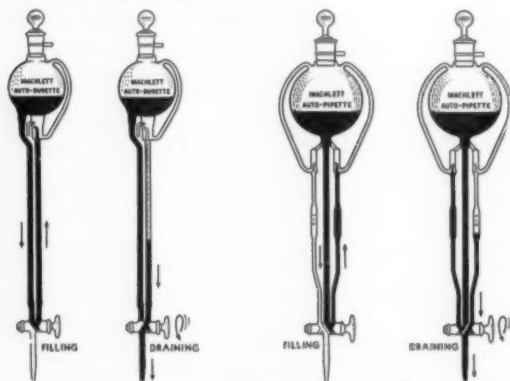
Through political and social upheavals and through great changes in science itself, *Nature* has remained an objective and dispassionate reporter of science and a forum for discussion of scientific matters. For 86 years it has provided a medium for reporting new discoveries and developments and for evaluating new books in science. It has offered opportunities for discussions of scientific policy, and sometimes has helped to steer the course of scientific progress. To its founders, editors, and publishers, science owes much. For the first international and comprehensive journal of science we wish a future as distinguished as its past.—D.W.

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Coincidence Method

W. Bothe

Before starting with my actual theme, may I be permitted to remember with a few words the man to whom, besides my teacher, Max Planck, I owe so much, and who died 10 years ago after a long and agonizing illness, Hans Geiger.

In the year 1912, Hans Geiger was called as director of the Laboratory for Radioactivity which was then to be newly established at the Physikalisch-Technische Reichsanstalt in Berlin-Charlottenburg under Emil Warburg's presidency. During the 6 years before joining the Reichsanstalt, Geiger worked in Manchester in Rutherford's Laboratory.

In June 1913, I became Geiger's assistant. At that time, the Laboratory for Radioactivity consisted of two rooms only. Later, when the number of measurements of radioactive substances increased considerably, it was enlarged to four rooms. Already this modest demand for space—Geiger repeatedly stated that he did not want a giant institute—is typical of the whole character of Geiger's scientific personality: the endeavor for economy in scientific work. This was to some extent certainly due to the unique influence of Rutherford, but it is equally certain that this influence met with his own natural outlook.

Certainly everybody recognized that the experiments by Geiger and Marsden on the scattering of alpha particles are

the basis of all the recent development in experimental, atomic, and nuclear physics. Mainly, I think, I learned from Geiger always to select from a large number of possible and useful experiments the one which at the time appeared to be the most important and to execute this experiment with simple equipment, which was versatile and adaptable also to other problems.

In the year 1924, I came upon the theoretical paper by Bohr, Kramers, and Slater that had just been published. In this paper the authors point to a possibility to understand the dualism (wave-corpulence) in the then current description of the properties of light. One has to understand the experimental fact that light of all wavelengths, as far as pure propagation is concerned, will behave like a wave (interference effects). However, if light is converted into a different form of energy, it behaves like a particle (light quanta: photo effect, Compton effect). The new idea was to deny the strict validity of the law of conservation of energy and momentum. In the single or elementary process, as long as a single emission only is taking place, the conservation laws should be fulfilled statistically only. For a macroscopic ensemble of many elementary processes, however, the conservation laws were supposed to be valid.

Thus there was agreement and no discrepancy with the then known experimental facts. It was at once quite clear that this question had to be decided by experiment before reliable progress could be made. That such an experimental decision is feasible was completely agreed upon by Geiger and myself as soon as we discussed the paper by Bohr, Kramers, and Slater.

Experiments with the Compton Effect

The experimental problem could be approached in various ways. We decided on an experiment about the Compton effect discovered somewhat earlier—namely, the scattering of light on practically free electrons. Besides the scattered light, there appear also the recoil electrons, which were observed by C. T. R. Wilson in a cloud chamber, and which I observed, both with a cloud chamber and with an ionization method, and recognized as recoil electrons. The question posed to nature that had to be answered experimentally was therefore: In the elementary process each time that a quantum is scattered and an electron recoils, are the two simultaneous or is there only a statistical coupling between the two? In the meantime, Geiger developed the so-called "point counter." This has the advantage of being sensitive, not only to heavy particles, but also to electrons and, therefore, also to light quanta of energy high enough to be able to release electrons in the interior of the counter.

Our arrangement consisted, therefore, of two point counters with a common frontpiece over which an x-ray beam passed without striking it. The x-ray beam passed through a hydrogen atmosphere. The Compton processes occurred in the interior of one of the counters, which registered the recoil electrons. In the other counter only scattered light quanta could penetrate and were registered with a much smaller probability by the secondary electrons released through the quanta. The pulses from the two counters were registered side by side on a movable paper film. In this way we were able, after a few unsuccessful attempts, to determine whether or not the two events were coincident within a time interval of 10^{-4} second or less. The amount of film used was so large that when the films were hung up to dry our laboratory gave the impression of a giant commercial laundry.

The final result was that actually systematic coincidences appeared with a frequency that could be expected from the experimental geometry and the detection efficiencies of the counters, assuming that in each elementary Compton process one scattered quantum and one recoil electron are produced simultaneously. The strict validity of the law of the conservation of energy even in the

Dr. Bothe is professor of physics and director of the Max Planck Institute of Physics in Heidelberg, Germany. This article is based on the lecture that he gave when he was awarded the Nobel prize for physics in 1954, a prize that he shared with Max Born. Dr. Bothe's manuscript was translated by Mrs. A. Akeley and R. M. Steffen, Purdue University, Lafayette, Ind., and is published here with permission of the Nobel Foundation. Dr. Born's lecture appeared in the issue of 14 October.

elementary process was thus proved, and the ingenious idea to solve the wave-corpuscle problem, as discussed by Bohr, Kramers, and Slater, was shown to be incompatible with the experiment.

This result was confirmed by several investigators using different experimental arrangements. When, after more than 10 years, some doubt was raised concerning the validity of these results, I tried with H. Maier-Leibnitz—then my collaborator—to improve and supplement the original experiment in one point. We wanted to show not only the simultaneity but also the correlation in direction between scattered quantum and recoil electron, as it must exist according to the Compton theory—this means according to the laws of elastic collision between two bodies. In this experiment the high-energy gamma radiation of a radiothorium source was used. The result again was definitely positive. Thus, not only the strict validity of the law of conservation of energy but also of the conservation of momentum was demonstrated.

The period of my work with Geiger ended unfortunately in 1925 when Geiger was called to the University of Kiel. Again, for reasons of "economy in science," we agreed that our common fields of investigation should be divided between us, and Geiger generously offered that further coincidence work, if any, should be performed in my laboratory.

The possibility of a mere statistical validity of the conservation laws, as discussed by Bohr, Kramers, and Slater, seemed important enough to justify the examination of an additional case. In the elementary process of light emission a spherical wave is sent out. The question is now: Can this spherical wave give rise to an absorption process in one direction only as required by the law of conservation of energy, or is it possible for absorption processes to occur in several directions, statistically independent as expected from the theory of Bohr, Kramers, and Slater?

In such an experiment it must be kept in mind that, contrary to the Compton effect, the detection probability of an

absorption process must not be much smaller than unity, since, otherwise, possibly occurring systematic coincidences would be overshadowed by the unavoidable chance coincidences. A high detection probability was achieved by choosing the source of radiation (iron or copper K fluorescent x-rays) and the gas (argon) of the two respective point counters in such a way that the absorption probability in the gas approaches unity. Obviously, it was also necessary to have the solid angles that the two point counters subtend at the source of radiation approach 2π as closely as possible. The result of this experiment (1926) indicated no systematic coincidences, at least not with a frequency expected according to Bohr, Kramers, and Slater. In this way, the strict conservation of energy in the elementary process was also assured by an experiment that gave a negative result.

The wave-corpuscle problem remained unsolved only for a short while longer. In this period, I had the good fortune to be able to discuss this problem with Einstein. Several experiments performed at Einstein's suggestion did not bring any decisively new results. The solution (at least the formal one) came later from wave mechanics: It is simply included in the assumption of the Schrödinger theory that the Schrödinger wave of a system of n particles is a wave in the $3n$ dimensional "configuration space."

Coincidence Counting of Cosmic Radiation

A completely different field in which the coincidence method proved extremely fruitful was the "cosmic radiation," or "ultra radiation" as it was called by its discoverer, V. Hess. In the meantime, Geiger in Kiel had developed the powerful tool of the Geiger-Müller tube counter. Coincidences between unshielded tube counters produced by cosmic rays were observed by Geiger himself as well as by W. Kolhoerster, who at this time was a guest in my Berlin laboratory.

Further important information was to be expected if absorbing layers of varying thickness were placed between or (and) above the tube counters. Such experiments performed jointly with Kolhoerster in 1929 allowed us to draw the conclusion that the cosmic radiation does not consist primarily of gamma rays, as it was generally assumed until then because of its high penetrating power, but of material particles with an energy of at least 1000 Mev. Later on, such coincidence-counter arrangements were used increasingly with more and more tube counters, sometimes also combined with cloud chambers, ionization chambers, scintillation counters, and so forth.

The nature of the primary cosmic radiation as very high energy particles was confirmed later, even though the process involved proved to be far more complex than we could surmise at that time. As a simple example we may mention that B. Rossi, also for some time a guest in my P.T.R. Laboratory, later succeeded in observing the first indications of the occurrence of particle showers by means of coincidences between tube counters placed next to each other in a horizontal plane (Rossi curve). Even today, the possibilities of applying the coincidence method in the field of cosmic rays are by no means exhausted.

The same principle that was used in measuring cosmic radiation can also be applied in measuring ordinary beta- and gamma-ray energies. It is, therefore, possible, with the use of only two tube counters and a variable absorber between them, to determine quite simply the average gamma energy in a mixture of gamma rays and their secondary electrons (Bothe and Becker, 1930). This method can be of use also, if for some reason the usual spectrometer method utilizing magnetic deflection cannot be applied.

In the meantime, the technique of coincidence counting was improved considerably. Instead of using the cumbersome photographic recording, we turned long ago to vacuum tube circuits in conjunction with mechanical counting devices. Not only has this the advantage of greater simplicity, but in this way it is also possible to reduce the so-called "resolving time" to such an order of magnitude that very often the disturbing "chance" coincidences are of no importance. I used such an electronic circuit with a multiple-grid coincidence tube as early as 1929. Another circuit that uses tubes connected in parallel was first designed by Rossi; it offers the advantage that it can be easily enlarged to be used for more than two coincident events, and, therefore, it is predominantly used nowadays. (Recently Z. Bay and coworkers in the U.S.A. were able to reduce the coincidence resolving time to 10^{-11} second by using electron multipliers.)

Discoveries in Nuclear Reactions

Another field in which the coincidence method can be used to great advantage is the field of nuclear reactions. It was found jointly by H. Fraenz and me (1928), as well as by Pose in Halle, that, in the artificial transmutation of a nucleus (B^{10} in our case) by alpha irradiation, several discrete proton groups of different energies appear. Shortly afterward (1930), I discovered with H. Becker the gamma rays that are emitted during alpha bombardment, not only of boron,



W. Bothe

but also of other elements. These two results have a common interpretation: the new nucleus produced during this transformation is not always formed right away in its ground state but is sometimes found in an excited state. In this case, the particle emitted during the reaction has correspondingly less energy, whereas the product nucleus changes into the ground state by emitting the stored energy in the form of gamma radiation. This change usually occurs within a time too small to be measured; therefore, it occurs practically at the same time as the emission of the new particle.

It is by no means trivial to prove the simultaneity of the two events, as one might think, because it may happen that the product nucleus is *always* produced in an excited state. This can be decided by coincidence measurements. In this case, even the particle group with the highest

energy would have to be followed by gamma radiation. However, this is not the case if this group corresponds to the transition to the ground state of the product nucleus. (In case of "metastable" excited states, these considerations obviously have to be modified.) Such measurements were first performed in 1935 by H. J. von Baeyer, a Heidelberg student of mine, on the transformation of boron by alpha bombardment, which has already been mentioned. In the same manner, it is possible to decide whether two or more gamma quanta are produced in the same nucleus in one nuclear reaction, therefore produced at the same time, or whether they are alternatively emitted in the transformation of different nuclei. Such questions are of importance in energy balance considerations and, therefore, in the measurement of reaction energies and nuclear masses.

Correlations in the directions of the different radiations emitted in a nuclear reaction and the angular distribution of the emitted radiation with respect to the direction of the bombarding radiation can also be determined and measured with coincidences. Experiments of this kind furnish valuable information concerning the structure of the atomic nucleus. Corresponding problems in the spontaneous transformations (natural and artificial radioactivity) can be attacked experimentally in the same way as was shown in the case of the decay of RaC (Bothe and Maier-Leibnitz in 1937).

The wide field of nuclear physics will offer in the future many possibilities for applications of the coincidence method. It can be stated without exaggeration that this method belongs to the necessary fundamental tools of the modern nuclear physicist.

Some Effects of Periodic X-radiation

Louis E. Moon, Harry F. Harlow, George P. Bogumill

Several studies have reported the effects of x-radiation on the physiology and behavior of animals, but generally they have employed a single, large dose of radiation. The present study (1) was undertaken to determine progressive behavioral and physiological changes occurring when animals are given repeated mild doses of x-radiation over a long period of time.

Twenty-three monkeys of the species *Macaca mulatta* were used in this investigation and were housed in pairs insofar as this was possible. Prior to radiation they were given extensive training on various tests that had been shown through previous experimentation to differentiate reliably between normal animals and those with various types of brain damage. Following this training, 12 of the 23 animals were randomly selected for radiation.

The weights of the experimental animals a week before radiation ranged from

5.19 to 9.44 pounds, with a mean of 7.24 ± 1.42 pounds, and the control animals weighed from 5.00 to 10.17 pounds, with a mean of 7.45 ± 1.73 pounds.

Radiation was accomplished by tying the animals in an adjustable, rotating plastic chair (Fig. 1) placed so that its axis of rotation, which was approximately the same as the long axis of the animal's body, was located 1 meter from the source of the x-rays. The whole body was irradiated, with the apex of the radiation cone located at the animal's midline slightly caudal to the heart. The x-ray machine used was a Westinghouse Quadrocondex, containing an XPT tube operating at 200-kilovolt peak and 10 milliamperes. The rays were filtered through 1 millimeter of aluminum and 0.5 millimeter of copper. The tube delivered from 6.0 to 6.2 roentgens per minute at a distance of 1 meter, and prior to each radiation the output was determined by means of a Victoreen roentgen-meter, and proper exposure times were calculated. The experimental animals were given 100 roentgens every 35 days until death.

The greatest number of roentgen units absorbed by any animal before death was 1200, in contrast with the results of Eldred and Trowbridge (2), who found that LD₁₀₀ for rhesus monkeys weighing 5 to 7 pounds was 800 roentgens for a single dose. These results conform to the finding of other researchers (3) that divided doses are not as lethally effective as a single dose. Because of the small number of animals and the occurrence of illness in the early stages of the project, no estimate of LD₅₀ is justified.

Radiation significantly affected animal weights. Eight experimental and eight control animals were paired on the basis of their mean weights for the 3-month period immediately preceding radiation. Between this period and the time of death of the experimental animal of each pair, the mean weight of the control subjects increased 9.6 percent, whereas that of experimental animals decreased by 4.7 percent. This difference is significant at the .01 level of confidence. A Pearson product-moment correlation of +.41 was obtained between mean weights of the experimental animals for the 3 months prior to radiation and the cumulative number of roentgens administered before death. Although it is not statistically significant for the number of animals involved, the positive direction of this correlation suggests that weight before radiation may have some relationship to radiation resistance in monkeys.

The first two experimental animals succumbed after dosages of 300 and 500 roentgens, respectively, and were found at autopsy to have pulmonary tuberculosis. The examination was discontinued when the opened chest cavity revealed this condition. The third animal, which died after receiving a total of 900 roent-

The authors are members of the Departments of Psychology and Anatomy, University of Wisconsin, Madison.

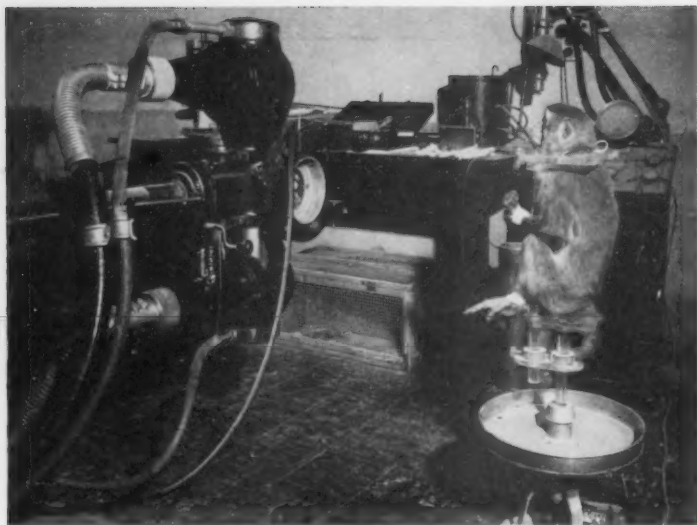


Fig. 1. One of the experimental monkeys in the chair in front of the x-ray apparatus. The chair is inserted into a motor-driven base that rotates the chair at 1 revolution per minute at constant speed.

gens over a period of 9 months, showed severe pathological heart changes consisting of widespread hemorrhages into all three layers of the cardiac wall, a partially healed infarction, and a recent mural thrombus attached to the medial cusp of the tricuspid valve. In addition the lungs showed pleural effusion, numerous petechial hemorrhages uniformly scattered over the lung surface, and filling of many of the alveolar air spaces with exudate. Gross examination of the cranial cavity revealed the presence of subarachnoid hemorrhages in the region of the cerebellar vermis, and there was subdural blood in the middle cranial fossae.

The autopsy findings on this third animal instigated a survey of the hematological condition of the remaining animals. Blood specimens from eight experimental and four control animals yielded decisive evidence of suppression of bone marrow function. The red cell count in each of the four animals that had received 900 roentgens was less than 2.5 million, an average of only 25 percent of that for the control animals. The four animals that had received 300 roentgens had a moderate anemia, their average count being 75 percent of that of the controls. The cases with severe anemia also showed extreme anisocytosis, poikilocytosis, hypochromia, nucleated red cells, and reticulocytes. Less severe changes in red cell morphology were seen in the moderate grades of anemia. White blood cell formation was also markedly depressed, to a point as low as 17 percent of the average count of the control group.

Every irradiated animal subjected to

autopsy showed severe pathological changes in at least one organ system, but in several cases two or more systems were severely involved. The organs most frequently damaged were the lungs, heart, kidneys, and large bowel. Marked congestion and interstitial hemorrhage occurred in the lung of one animal. Severe cardiac damage, with myocardial hemorrhage and infarction, was present in three monkeys. Tubular degeneration with glomerular and interstitial hemorrhage characterized the renal lesions that were present in four cases. Three monkeys exhibited damage to the large bowel, segments of which showed gross discoloration with thickening and induration.

Various tests of learning ability and measures of motivation were repeatedly administered to all monkeys throughout the course of the project. The ability of the animals to learn to discriminate between rewarded and unrewarded objects, to respond correctly after various intervals of delay up to 20 seconds to the one of two identical objects under which a reward had been concealed, and to learn other, more difficult tasks was measured.

Although no over-all significant differences were found between the performances of control and irradiated monkeys on any test, the irradiated animals were significantly superior to the controls on both oddity and delayed-response tests during the last 2 test-months. Irradiated monkeys showed no deterioration of their ability to solve even the most complex learning problems, and it was repeatedly observed that animals on the verge of death nevertheless maintained their high level of performance until they had be-

come so weak that response was no longer possible. The irradiated monkeys, however, did show significant decreases in general body activity and in appetite, with these decreases tending to become greater as the absorbed cumulative dose of roentgen units increased.

Locomotor activity was measured in a cage that was divided into quadrants by two intersecting photoelectric beams. Movement of the animal from one quadrant to another interrupted the beams, and the total number of such interruptions over five consecutive daily 20-minute test periods was recorded. No significant differences were found between irradiated and control monkeys on the first administration of the test, given after the experimental group had received an accumulative total of 300 roentgens. When the test was again administered to the control group and to the surviving irradiated monkeys that had absorbed a cumulative total of 900 roentgens, it was found that the locomotor activity level of the experimental monkeys was significantly lower than that of the controls.

Appetite was measured by presenting the animals with 45 raisins in food wells on a tray and counting the number of raisins secured by each animal within each of five consecutive 30-second trials per day on 4 successive days. This test was first given after the irradiated group had received a total of 300 roentgens, and again after a total of 900 roentgens. On both series experimental subjects satiated more rapidly than controls over the five daily trials, and their intake fell off progressively over the 4 days of the test, whereas control animals showed no substantial change in intake over the 4 days. These differences were significant beyond the .001 level of confidence.

The learning test results parallel those of Kaplan, Gentry, Melching, and Delit (4), who found that accuracy of performance and reaction times in a discrimination-retention problem were not significantly affected, even though the animals had received a dose of x-radiation that shortly proved to be lethal. They also found a rapid increase after irradiation in a failure to respond, which may be related to the activity and appetite decreases found in the present project.

References and Notes

1. These researches were supported in part by a grant to the University of Wisconsin from the Atomic Energy Commission contract AT(11-1)-64 and in part by the Research Committee of the Graduate School from funds supplied by the Wisconsin Alumni Research Foundation.
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R. W. Wood, Physicist

With the death of R. W. Wood, American physics has lost its most colorful figure. His passing away also underlines the end of a period in which individuals working with extremely simple means and practically unaided could make major contributions to their field. R. W. Wood was one of the chief exponents of this era.

The skeleton of his life's history can be told in a few words. He came from a prominent New England family and studied at Harvard University, where he received his bachelor's degree in 1891. He did not distinguish himself in those fields which were at that time believed to be the backbone of an education, but flashes of his originality and great gifts for the natural sciences became apparent at that time. He went as a graduate student of chemistry, first to Johns Hopkins University and then to the newly opened University of Chicago; after that he spent 2 years at the University of Berlin where, mostly under the influence of Rubens, he definitely changed from chemistry to physics. His first position was as instructor at the University of Wisconsin, which he held from 1897 to 1901. Here his flair for originality and inventiveness developed, and his name became so well known that, when Rowland died, Johns Hopkins University offered him the professorship of experimental physics as Rowland's successor, a post which he held from 1901 to his retirement in 1938, at which time he was appointed research professor of physics. He retained this appointment until his death.

In his chief field of endeavor, physical optics, Wood made many important contributions. The first 30 years of his work as a physicist coincide with the period when our knowledge of the structure of the atom gradually evolved and became more and more precise and detailed. Experiments in spectroscopy and other branches of physical optics were perhaps the chief sources for this knowledge. Wood's best known contributions were the line and continuous absorption of sodium vapor, fluorescence phenomena, particularly the discovery of the resonance radiation of gases and vapors and the influence of foreign gases and mag-

netic fields on such phenomena. With these discoveries he opened up a new field, which was taken up by many others during the second and third decades of this century. The subjects mentioned by no means even approximately indicate the versatility of his work. He made contributions in such diverse fields as x-rays, photography, meteorology, archeology, explosives, and acoustics. In fact, it almost became a standing joke that if anyone came along with a new discovery Wood pointed out that he had done the same thing 30 or 40 years earlier. The joke was that this was always found to be true.

Although this great variety of contributions makes it impossible to discuss any of them in detail, his success in perfecting the art of ruling diffraction gratings should be singled out, because this has benefited practically every physics laboratory and astronomical observatory in the world. The grating as a precision instrument was invented by Rowland. Wood inherited the machines designed by Rowland for ruling such gratings. He devised a number of improvements and, what is perhaps even more important, managed to keep the engines at work so that a constant stream of gratings came out of his laboratory. This was for many years almost the only source of supply for these very vital parts of a spectrograph. Since the use of spectrographs in science and industry had expanded tremendously with the years, this alone was a contribution of major importance.

Wood was by no means a worker in an ivory tower. He made many practical inventions and was greatly in demand by the military as scientific expert during the two World Wars and also in criminal and civil court cases. He acquired quite a reputation as a scientific detective; he himself and others could tell many anecdotes about his adventures in these fields. He also was a gifted painter and published a collection of nonsense verses (*How to Tell the Birds from the Flowers*) that went through more than 19 editions. He even tried his hand at science fiction.

His eminence as a physicist found wide recognition. Although in his youth

he never could satisfy the conditions for a doctor's degree, he held many honorary degrees, among these doctor's degrees from Clark, Oxford, Birmingham, Edinburgh, Berlin, and Johns Hopkins universities. He was a member or honorary member of innumerable learned societies, among which were such ancient and illustrious ones as the Royal Society, the Accademia dei Lincei, the Leningrad Academy, and the Royal Swedish Academy. Of the many medals he received I mention only the Rumford medal of the Royal Society (1938), which is to be distinguished from the Rumford medal of the American Academy of Arts and Sciences which he had received 30 years earlier.

R. W. Wood was unquestionably a great physicist and a brilliant experimenter to whom science owes a great deal. The question of what makes a man great is always of interest. A man may become a great physicist because he possesses superb technical skill and can do experiments that are so difficult that they cannot be done by anyone else. This certainly was not true for Wood, because apparatus of even moderate complexity could leave him baffled. His success cannot be attributed to any particular insight into the mathematical intricacies of a problem, for even simple mathematical expressions could leave him helpless. Others do great things because they have the gift of organizing and creating great schools. Wood always was happiest when he worked by himself. He had, of course, manual skill, since he made most of his equipment himself, but the equipment he used was always simple and sometimes primitive. I believe that what was perhaps foremost in him was an intense curiosity that drove him to ask himself questions about the nature of things. He would then look at the problem from all sides until a simple approach presented itself to him. He never tired until he had solved the problem to his entire satisfaction and left no loopholes.

Wood in his later days had become a legend. Perhaps his life and work should be a warning to those who decide the fate of graduate students not to be bound by too rigid rules and to encourage youthful genius and originality, even if it is disdainful of strict rules and conventional book learning. Wood, with his disregard for traditional knowledge (which he often considered only an irksome encumbrance), probably would not be admitted by a graduate school now. Even in his day he did not qualify for a higher degree. The many honors he received later showed how wrong were the rules that barred him from it.

G. H. DIEKE

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News of Science

FAO Decennial

■ The Food and Agricultural Organization of the United Nations has begun its second decade of operation. A decennial celebration was held 14-16 Oct. at the Chateau Frontenac, Quebec, Canada. Participating in the observance were agricultural officials of the United States, Canada, and the FAO North American Regional Office. The Quebec site was chosen for the ceremonies because FAO's organizing conference was held there on 16 Oct. 1945.

Since that time the organization has grown from 42 to 71 member nations. It is the only international agency set up to deal directly with the immediate and long-range problems of food and farming throughout the world.

In May 1943 representatives of governments of 45 countries met at Hot Springs, Va., to seek ways to banish hunger and establish a stable world agriculture. It was thought that international cooperation might be kept alive if it was centered around urgent practical matters outside the realm of international politics—such problems as how to apply modern agricultural science more widely, how to apply modern nutrition, and how to raise living standards and conditions of rural people. Since at that time food was one of the world's greatest problems, the representatives to the Hot Springs conference decided to create a worldwide organization that would work toward adequate food supplies for all people.

FAO was the first of the permanent agencies that were born from the wartime partnership of the Allies. John Boyd Orr, nutritionist and founder and head of the Rowett Research Institute, Aberdeen, Scotland, was elected first director-general. The motto *Fiat Panis* (Let There Be Bread) was adopted.

FAO is a specialized agency of the United Nations system—that is, an organizational entity separate from the U.N. It has its own constitution and governing body made up of member nations. FAO operates, however, under an agreement with the U.N. to work cooperatively toward common objectives. Some member governments of FAO are not members of the U.N. and vice-versa. The

purpose of this agreement with the U.N. is to make possible the concentration of technical knowledge on world agricultural problems, and at the same time to provide joint action on mutual international problems.

Under FAO's constitution, member nations are pledged to carry out the following objectives: (i) to raise the levels of nutrition and standards of living of the peoples of their country and the world; (ii) to secure improvements in the efficiency of production and distribution of all food and agricultural products; (iii) to better the condition of rural populations; (iv) to contribute toward an expanding economy.

To carry out these objectives, FAO's work is divided into three principal categories: (i) it collects, analyzes, and distributes to member nations the basic facts on food and agriculture, forestry, and fisheries; (ii) it promotes concerted national and international action by recommending definite ways and means for putting the latest facts and scientific methods to use; and (iii) it gives technical assistance to member countries requesting it.

A world food survey in 1946 was one of the first jobs completed by FAO. This survey demonstrated the value of collecting basic data on just how much food different peoples are getting and how that amount compares with their need. The survey indicated that more than half the world's peoples did not have enough food to maintain normal health prior to World War II. FAO has continued to make annual reports on world food and agriculture.

When a member country requests technical assistance from FAO on its particular problems, FAO can send one or more qualified individuals to work with scientists and technicians of the country. FAO now employs several hundred specialists in virtually every phase of agriculture, forestry, and fisheries and has them working in many parts of the world.

FAO promotes and coordinates international action in many ways. Greece set up a national nutrition service on FAO's recommendation. The locust problem in several Central American countries and in the Middle East has

been minimized through a cooperative program in which FAO has assisted.

Many international commissions and study groups have been established through the aid and encouragement of FAO. An example is the International Rice Commission, whose purpose is to raise production and consumption levels in rice-eating countries. In recent years, FAO has studied the appearance of surpluses of certain crops in several countries. After the 1953 FAO conference, it created a committee to work specifically toward an orderly solution of these problems. This committee, made up of representatives of 21 member governments, including the U.S., periodically meets to discuss possible solutions to the surplus commodity situation.

FAO, in reviewing agricultural development of the past decade, says that world agricultural production was more than 25 percent greater in 1954 than it was in 1946-47 (excluding the Communist bloc). The world is now producing about 20 percent more rice, milk, and cotton than it was before the war; about 30 percent more wheat, fats, and meat; 50 percent more fruit and sugar; and 80 percent more natural rubber.

World fisheries' production, seriously reduced during the war because of loss of fishing boats, has increased 20 percent over prewar figures. At the end of the war, FAO estimated that world agricultural production was down 5 percent and that world population was up 10 percent from prewar levels, with a consequent per-capita fall in production of about 15 percent. By 1954 production was up again, however, and in some countries surpluses were beginning to develop in wheat, sugar, and cotton.

In fact, the changing picture of world trade has been striking. Until 1952, North American food exports were three to four times larger than they had been before the war, but at that time they began to decline. On the other hand, food exports from the Far East are still less than half the prewar volume. European food imports, once high, have settled down to a figure of about 10 percent lower than before the war. Latin American food imports, although they have increased sharply, remain relatively small. FAO reports that slowness in world trade of agricultural products arises largely from the drive for greater self-sufficiency.

Dorset Dwellings

Big, roofless stone houses that belonged to the Dorset people were discovered on Walrus Island in the Canadian subarctic this summer by Henry B. Collins, archeologist for the Smithsonian Institution. These houses, arranged in a

settlement and so well preserved that they can hardly be more than several hundred years old, are probably the most recent such remains ever found. Previously the Dorset people, whose ancestors were the first human beings known to have spread across arctic North America, were thought to have disappeared nearly a thousand years ago.

The discovery came almost by accident. Walrus is a small granite islet scarcely a mile long. Collins and his party visited it during a side trip from their main base on Southampton Island, northern Hudson Bay, where the expedition had been excavating the site of one of the oldest Dorset settlements known.

The houses found on Walrus Island were built of massive granite blocks and boulders piled in the form of walls around deep excavations in the frozen soil. These walls were fairly well constructed. There were houses of one, two, and three rooms. The latter were in the general shape of a clover leaf. All were roofless.

Until the present, according to Collins, the Dorset people have been one of the greatest puzzles of arctic anthropology. Little has been known of their dwellings or of their manner of living. Their harpoon heads, knives, and other implements are so different from those of other Eskimos that some had thought they might have been of Indian ancestry rather than Eskimo.

Collins reports that "These questions have been considerably clarified by our discoveries on Walrus Island and nearby Southampton this summer. The significant thing about our discovery is that it indicates the Dorset people did not mysteriously disappear as has been supposed, but that their culture persisted until fairly recently. It suggests that theirs was the dominant, basic culture of the central Arctic for over a thousand years. It also removes any doubt of the Dorset people being anything but Eskimo. Some of their culture traits and presumably their blood undoubtedly still persist among present-day Eskimos in the Canadian Arctic."

According to Collins, the outstanding characteristic of the Dorset Eskimos was their use of tiny tools made of chert; the tools are so small that a whole tool kit of knives, scrapers, side blades and burins, scarcely covers the palm of one's hand. Tools were found at both sites, but those from Southampton represent a much earlier stage of the culture. Collins believes that the earlier stage is more than 1000 years old. He considers the Southampton tools to be prototypes of the implements and weapons found on Walrus Island.

The expedition's work this summer, Collins says, throws new light on the history of human occupation of the

arctic. There were two distinct migrations out of Alaska across Canada. One migration is represented by the Thule people, whose traits constitute the most prominent element in the culture of present-day Eskimos. The Thule people used heavy weapons somewhat crudely designed. The other migration is represented by the Dorset people, whose ancestors left Alaska at a much earlier time. The path of their migration is less satisfactorily known.

In some ways the cultures of these two stone-age peoples were similar, in others quite different. Both were sea-mammal hunters and both built stone houses. But the Dorset craftsmanship is characterized by small, nicely designed weapons made of ivory, bone, and stone. The Dorset people also displayed high artistic ability; they left skillfully carved animal and human figures in ivory and bone. In the course of centuries the two peoples apparently mixed. Ways of life were borrowed and elements of Thule culture were superimposed on the Dorset, the result being the present Eskimo culture.

The expedition, Collins' second to Southampton Island, was a joint enterprise of the Smithsonian Institution, the National Museum of Canada, and the American Philosophical Society. Transportation to and from Southampton was provided by the Royal Canadian Air Force. Other members of the expedition were J. N. Emerson of the University of Toronto; William E. Taylor, Jr., of the National Museum of Canada; and James V. Wright, University of Toronto student in anthropology. The expedition brought back extensive collections of plants, insects, and fossils.

News Briefs

■ Honeybees are able to make use of an internal "clock" to gage the passage of 24 hours, according to a report by Max Renner, zoologist of the University of Munich, who this summer conducted a transoceanic experiment at the American Museum of Natural History and the University of Paris. The results of the experiment, which were made public by Theodore C. Schneirla, curator in the American Museum's department of animal behavior, indicate that a bee's memory of time intervals can function independently of regular external factors such as the rhythm of night and day.

The existence of a bee's internal clock was finally established at the conclusion of a two-phase project that was conducted under nearly identical conditions in both New York and Paris. First a colony of bees, a group of which had been trained to forage for food at a particular time each day in a specially constructed testing room in Paris, was flown

to New York between feeding periods. Three days of testing without food in an identically constructed testing room at the American Museum showed that the bees maintained their 24-hour foraging schedule, regardless of the geographic change and the 5-hour difference in sun time.

Similarly, a second group of bees trained in New York maintained their 24-hour schedule after they had been flown to Paris.

It has long been known that if food is available at a certain place at only one time of day, bees soon learn to visit that place during only that time each day. Previous experiments had also shown that bees could be trained to feed at a certain place only at 24-hour intervals, not at periods of greater or lesser frequency. Purpose of the transoceanic test was to determine whether or not the 24-hour cycle is controlled by endogenous influences—that is, intrinsic timing devices in the insect's metabolism—or by exogenous factors that might be celestial or cosmic.

Still unanswered is the question of whether or not the 24-hour feeding cycle is innate in bees or whether it is impressed on them during their early development by environmental factors and continues to function when these factors are eliminated under laboratory conditions.

■ The Department of Defense has announced that a preliminary contract for production of a satellite has been awarded to the Glenn L. Martin Company of Baltimore, Md. The department also authorized a contract with General Electric Company for a first-stage rocket motor. The Martin Company, as the primary contractor, will produce the launching vehicle.

Other private contractors will be brought into Project Vanguard as it develops. The Navy Department has been designated executive agent for the project and will award the contracts. The chief of Naval Research, F. R. Furth, will exercise general supervision over Project Vanguard and will coordinate the contributions that may be made by the Army and Air Force as well as the Navy. John P. Hagen of the Naval Research Laboratory has been designated project director.

In the initial White House announcement of the International Geophysical Year satellite program, it was officially estimated that the project would cost \$10,000,000, "exclusive of the launching operation itself." Hugh Odishaw, executive secretary of the United States National Committee for IGY has stated that approximately 10 satellites would be hurled into space into different orbits. He explained that in their elliptical

courses the satellites would range from 800 to 200 miles from the earth.

Although the exact shape and size of the satellite itself has not yet been determined, it will be small but large enough to contain a number of instruments and to be tracked from the ground by optical and radio devices.

Vanguard, the first vehicle, will be established in its orbit around the earth in the following general manner: the first rocket will start the entire assembly vertically on the first part of its flight. When its fuel is exhausted, the first stage will drop off and the second rocket, deflected from the vertical, will continue the satellite upward.

The third rocket, carrying the satellite proper, will accelerate it to a top speed of about 18,000 miles an hour, which will establish the satellite in its orbit, where it will continue under its own momentum.

The satellite's orbit will be elliptical rather than circular, and, at its perigee, may be approximately 200 miles distant. The satellite will revolve about the earth once every 1 or 2 hours for several days.

The cumulative effect of the drag of the earth's atmosphere, thin though it is at a 200-mile altitude, will still be sufficient to bring the satellite gradually closer to the earth. The friction of the air will cause the satellite to disintegrate as it enters the denser atmosphere.

■ The research vessels *Spencer F. Baird* and *Horizon* of the University of California's Scripps Institution of Oceanography have sailed from San Diego on the first leg of an oceanographic expedition to the waters of Central South America. The scientific leader of the voyage, which is called the Eastrop Expedition, is Townsend Cromwell, oceanographer for the Inter-American Tropical Tuna Commission, and a research associate at Scripps. He is aboard the *Baird*. Chief scientist aboard the *Horizon* is John A. Knauss of Scripps.

The ships will join vessels from the California Department of Fish and Game and from the U.S. Fish and Wildlife Service group at Honolulu for work in the eastern tropical Pacific. A vessel from the Peruvian Navy may participate in investigations off Peru. The Scripps vessels are due to return to San Diego on approximately 15 Dec.

In addition to regular oceanographic survey work, the expedition will make detailed studies of several areas in the tropical Pacific, including a rich tuna-fishing region off Costa Rica.

■ The first coelacanth that has thus far been observed alive lived less than a day after capture. Its death has been ascribed by J. Millot [*Nature*, 175, 362 (26 Feb. 1955)] to decompression com-

bined with rise in temperature of the water. J. Smith, however, doubts this diagnosis, for in 1938 the first of these fishes ever secured lived for more than 3 hours out of water on a trawler's deck during an unusually hot day [*Nature* 176, 473 (3 Sept. 1955)].

Smith points out that large fishes taken alive on a line after struggling, despite the absence of any visible injury, rarely live for more than a short time even when they are set free. Curiously, fishes that have been harpooned, even though severely gashed, have a greater incidence of survival than those caught on hooks.

Smith suggests that "high nervous tension" produced by the conditions under which the coelacanth was kept after its capture may have contributed to its early demise. He also doubts the reported extreme photophobia of the animal, and regards its reactions to sunlight as merely natural uneasiness toward unfamiliar surroundings that became increasingly obvious to observers from dawn onward.—W.L.S., JR.

■ Understanding of superconductivity, the property of certain materials at a sharply defined low temperature to show immeasurably small electric resistance, presents a great challenge to solid-state physics. In recent years a number of new superconductors have been prepared and some successful attempts to formulate a theory have been made.

W. Buckel of Göttingen, Germany, [*Naturwissenschaften*, 42, 451 (August 1955)] reviews new experimental results in the field of superconductivity. This article, which has 125 references, discusses (i) new superconductors; (ii) change of physical properties at the onset of superconduction; (iii) the isotope effect; (iv) the effects of pressure and lattice effects on the characteristic properties of superconductors; (v) the transition state; (vi) experiments on the phenomenological theory of superconduction; (vii) theory; and (viii) application of superconduction.

Superconductors have been used as bolometers and radio detectors, and a superconducting galvanometer with an inner resistance of 10^{-7} ohms has been constructed so that a sensitivity of 10^{-12} volts can be reached. Particularly important is the use of superconducting switches in thermostating at temperatures below 1°K.

■ The U.S. Naval Radiological Defense Laboratory, an \$8 million facility for studying protective measures against radiation, was dedicated at the Hunters Point Naval Yard in San Francisco on 14 Oct. The decision to establish the laboratory was a result of the Bikini nuclear explosion and the attempt to decontaminate ships used in the tests.

Scientists in the News

ALBERT SCHWEITZER, scientist, missionary, musician, philosopher, and Nobel prize winner who for 41 years has been physician to lepers of the Congo area, was honored on 19 Oct. by Queen Elizabeth with the insignia of an honorary member of the Order of Merit. This order may be held by only 24 living Britons. The only other living non-Briton to be an honorary member is President Eisenhower. The presentation took place at a full-scale state ceremony.

Schweitzer's visit to England from his home in Alsace has received a great deal of attention in the London newspapers. In one encounter with the press, he interviewed himself.

"You will ask me where I have been lately," he said. "In Gunsbach in Alsace. There I meet old friends and recognize big trees which were only saplings when I was a boy."

"When do I go back to Africa? In December . . . after finishing some manuscripts."

"Then you ask what the manuscripts are about. But no, that I will not tell you."

ALBERTO F. THOMPSON has been named head of the Office of Scientific Information of the National Science Foundation, and CLYDE C. HALL, public information officer. Thompson, a chemist, joins NSF from the Atomic Energy Commission, where he has served for the past years as chief of technical information. He was in charge of the United States exhibit at the recent International Conference on the Peaceful Uses of Atomic Energy in Geneva.

Hall has been serving as special placement representative for the Civil Service Commission, where his major responsibility was the identification and placement of management specialists in the Federal services.

SANFORD S. ATWOOD, plant scientist and dean of Cornell University Graduate School, has been named provost of the university. He succeeds FORREST F. HILL, who will join the Ford Foundation as vice president in the area of overseas operations. Atwood will retain the deanship until a successor has been selected.

LEE DE FOREST, whose pioneering efforts in electronics have led to modern instrumentation and automation, was presented the first ISA achievement award by the Instrument Society of America at its 10th annual Instrument-Automation Conference and Exhibit in Los Angeles, Calif., 12-16 Sept. De Forest is widely known for his invention 50 years ago of the first radio vacuum

tube—the Audion tube, which was the first three-electrode tube with a wire grid between anode and cathode. In 1912 he invented the Oscillon, which incorporated feedback principles.

He then began regular radio broadcasts in the New York area and later on a larger scale in San Francisco. After failing to convince the movie industry that sound movies were possible, de Forest returned to New York and produced his own talking pictures. Since 1930, de Forest has devoted most of his time to the field of high-frequency therapy.

THEODORE SHEDLOVSKY of the Rockefeller Institute was this year's McGregory lecturer at Colgate University. On 3 Nov. he spoke on "Electrochemistry in biology and medicine."

Thirteen physicians and surgeons from 12 countries are making a 5-week tour of atomic medical facilities in the United States under the sponsorship of the Atomic Energy Commission and the Department of State. The American Council of Education is in charge of arrangements for the group. A similar tour in June and July of this year included 23 medical men from 12 nations.

The visitors are studying the uses of isotopes, reactors, and atomic medical and research techniques, particularly those concerned with cancer research and treatment. The group is visiting laboratories, hospitals, and research centers in and near Chicago, San Francisco, Boston, and New York. The group includes the following representatives:

Burma: PONDICHERRY R. MOHAN of the Rangoon General Hospital and the Rangoon Medical College.

Chile: CARLOS S. ELIZALDE of the Radium Institute, Santiago.

Ecuador: TEODORO S. ZAMBRANO of the School of Medical Sciences, Central University.

France: JEAN CANIVET of the French Atomic Energy Commission.

Guatemala: ALBERTO V. DAVILA of the Ministry of Public Health and the Guatemala General Hospital.

Indonesia: BAGINDA S. SASAD of the University of Indonesia.

Lebanon: NEGIB C. SAAD of Beirut.

Luxembourg: RAYMOND SCHAUS, at present attached to the Washington University School of Medicine (St. Louis).

Paraguay: MANUEL RIVEROS of National University of Asunción.

Portugal: MANOEL DE MENDONÇA CORTE-REAL of the Civil Hospitals of Lisbon.

Uruguay: MARTIN MIQUECO-NARANCO of the Uruguayan Cancer Control Society.

Turkey: FATMA P. GAMBEL of the Ankara Numune Hospital.

AUGUSTINE R. MARUSI, president of the Borden Company's chemical division, has been elected a vice president of the company. As president of the division, Marusi has charge of 18 plants, 11 in the United States and seven abroad, as well as the General Research Laboratory in Philadelphia, Pa. The plants produce adhesives, caseins, resins, molding compounds, and industrial chemicals.

THOMAS D. PHILLIPS has retired from the Marietta College faculty after 35 years' service as a member of the physics department. Head of the department for many years, Phillips' retirement was effective on 10 Oct. WILLIAM H. DAVIS has been promoted to professor and will assume duties as department head. Phillips' retirement date was advanced by several months in order that he might accept a position as technical writer with the Potomac River Naval Command, Indian Head, Md.

Phillips first joined the Marietta faculty as an instructor in 1920. He served as assistant professor during 1923-24 and 1927-30, then was made professor in 1930. He graduated from Oberlin College in 1916, where he was elected to Phi Beta Kappa. He received his master-of-science degree from the University of Michigan in 1923, and his doctorate from Boston University in 1934.

ROBERT C. HERMAN is serving as visiting professor at the University of Maryland for the academic year 1955-56 while on leave from his permanent position as consultant to the director of the Applied Physics Laboratory of Johns Hopkins University. During his year at Maryland, Herman will teach advanced courses in modern physics and will collaborate with several of the research groups in the physics department. He also will continue his previous study of imperfection centers in alkali halides, of rotational-vibrational spectra, and of the origin of the elements.

WILLARD P. CONNER, manager of the physics division at Hercules Powder Company's Experiment Station, has been loaned by Hercules for 1 year to serve as acting technical director of the materials testing reactor that is operated at the National Reactor Testing Station near Arco, Idaho.

I. I. RABI of Columbia University, Nobel laureate and physicist, delivered the first public, nontechnical Morris Loeb lecture at Harvard University on 21 Oct.; his topic was "Science and the humanities." Heretofore the Loeb lectures have been technical and have been addressed to invited audiences of scientists. Rabi also presented four scientific

lectures under the Loeb lectureship on the general theme, "Molecular beam experiments."

FRANKLIN K. MOORE has been appointed head of the aerodynamic research department at Cornell Aeronautical Laboratory, Inc. He was formerly a consultant to the supersonic propeller division of the Lewis Propulsion Laboratory, National Advisory Committee for Aeronautics, Cleveland, Ohio. He succeeds ALEXANDER H. FLAX, who was recently appointed assistant director of Cornell Aeronautical.

W. E. HEMING of Ontario Agricultural College, Canada, has been appointed head of the department of entomology and zoology. He succeeds A. W. BAKER, who retired recently.

The Franklin Institute of the State of Pennsylvania awarded 11 achievement medals at its annual Medal Day ceremonies on 19 Oct. Those honored were the following:

CLAUDE E. SHANNON of Bell Telephone Laboratories received the Stuart Ballantine medal for his development of an algebra that is used in the design and analysis of computers, telephone offices, and other automatic devices. He was also the guest speaker.

CHARLES S. LEOPOLD, a Philadelphia consulting engineer, received the Frank P. Brown medal for his contributions to air conditioning.

DAVID ALBERT HUFFMAN, assistant professor of electrical engineering at Massachusetts Institute of Technology, received the Louis E. Levy medal for his paper, "Synthesis of sequential switching circuits."

CECIL WALLER of Ilford, Ltd., and ROBERT BERRIMAN of Kodak, Ltd., English emulsion chemists, received Edward Longstreth medals for their contributions to "the development of photographic emulsions especially designed for the study of nuclear particles and events, which have made possible important new advances in this field, including the discovery of new nuclear particles and a better understanding of cosmic rays." The two worked entirely independently; their work is in the same field and is complementary.

F. P. BOWDEN, physical chemist of the University of Cambridge, England, received the Elliott Cresson medal for his "extensive experimental investigations which combine simplicity and clarity, and for his findings regarding the detailed nature of the processes involved when one metal slides over another."

RENÉ A. HIGONNET and LOUIS M. MOY-ROUD, French communications engineers, both of Cambridge, Mass., received John Price Wetherill medals for their concep-

tion and development of the Photon type-composing machine.

JACQUES V. P. SEJOURNET, managing director of Comptoir Industriel d'Etirage et Profilage de Metaux, Persan, France, also received a John Price Wetherill medal for his invention of the Ugine-Sejournet extrusion process for metals, which stressed the utilization of glass as a lubricant.

RICHARD V. CASE, assistant manager and chief engineer for the power transmission department, United States Rubber Company, received an Edward Longstreth medal for his invention of a timing belt for precision timing among shafts of industrial machines.

CARLETON K. STEINS, a mechanical engineer for the Pennsylvania Railroad, received the George R. Henderson medal for inventions that have contributed to the progress and efficiency of the railroad transportation system.

The following are among those who have received honorary doctoral degrees.

McGill University, Montreal: J. B. COLLIP, dean of medicine at the University of Western Ontario and director of the division of medical research, Canadian National Research Council; OTTO MAASS, a principal research officer in the division of pure chemistry of the Canadian National Research Council; E. G. D. MURRAY, bacteriologist, research professor at the University of Western Ontario.

Lehigh University: HOWARD A. RUSK, chairman of the department of physical medicine and rehabilitation of the New York University-Bellevue Medical Center.

The following appointments to assistant professor have been announced. State University of Iowa: IAIN MACLEAN SMITH and JACK M. MARTT, internal medicine.

Necrology

SIEGFRIED BLOCK, New York, N.Y.; 73; neurologist and psychiatrist; instructor in nervous and mental diseases at Long Island Medical College; advocate of children's courts; 18 Oct.

LEWIS R. BURDICK, Silver Spring, Md.; 54; senior fuels engineer with the branch of bituminous coal, Bureau of Mines, Washington, D.C.; 13 Oct.

HARRY B. HUMPHREY, Los Altos, Calif.; 82; retired U.S. Department of Agriculture plant pathologist; 13 Oct.

CARL R. MOORE, Chicago, Ill.; 62; chairman of the department of zoology at the University of Chicago; international authority on the biology of sex; 1943 vice president for AAAS Section F—Zoological Sciences; 16 Oct.

GEORGE T. RENNER, Leonia, N.J.; 55;

professor of geography at Teachers College, Columbia University; author or co-author of 19 books and numerous papers and pamphlets; 14 Oct.

Education

■ The 100th anniversary of the founding of the department of metallurgy at Yale University was celebrated on 14 and 15 Oct. The convocation also marked the 50th anniversary of the university's Hammond Metallurgical Laboratory.

■ The Research Unit of the Blue Bird Children's Clinic for Neurological Disorders, Houston, Tex., was officially opened on 15 Oct. This unit is for fundamental research in the physiology of the nervous system. The clinic and research unit are affiliated with Baylor University College of Medicine and Methodist Hospital, Houston, Tex.

Claude Fortier has been appointed director of the laboratories of neuroendocrinology, the first section of the Research Unit to be activated. Fortier was formerly assistant professor in the Institute of Experimental Medicine and Surgery at the University of Montreal and more recently research associate in the department of neuroendocrinology at the Institute of Psychiatry, University of London. In addition to his appointment in the Blue Bird Children's Clinic, Fortier has been appointed to the faculty of Baylor University College of Medicine as associate professor of physiology.

■ Operation of the high-altitude wind tunnel has begun at the University of California's Engineering Field Station in Richmond. The tunnel is four times more powerful than the university's former model. Under the supervision of F. C. Hurlbut, a physicist, the new facility will be used to study the behavior of objects traveling more than six times the speed of sound at altitudes 20 to 80 miles above the earth. Support for the research program comes from the Office of Naval Research, the National Advisory Committee for Aeronautics, and the Office of Scientific Research and the Air Research and Development Command of the U.S. Air Force.

■ The University of Michigan has initiated a new and more liberal foreign language requirement for Ph.D. candidates. The plan will permit students in certain departments to substitute an integrated program of graduate course work—at least 9 hours—for one of the languages usually required for the doctorate. In other cases students will be permitted to substitute another foreign language for the customary French or German. Also, a student whose native

language is not English, and who plans to return to his home country at the completion of his study, will be permitted to offer English as one language toward the requirement.

Individual departments of the graduate school are now submitting suggested programs of course work that might be substituted for a language. Two departments have had such programs approved—psychology and fisheries. Examples of course-work areas that have been approved in psychology are: mathematics, including statistics; anthropology; biochemistry; comparative literature; and programs in various area studies.

The new plan is in line with a general trend toward liberalizing doctoral language requirements. Institutions that have already established similar plans include Harvard University, Columbia University, the University of Chicago, and the University of Minnesota.

Grants, Fellowships, and Awards

■ Nominations are invited for the \$1000 Osborne and Mendel award, which was established by the Nutrition Foundation, Inc., for the recognition of outstanding accomplishments in the general field of exploratory research in the science of nutrition. It shall be given to the investigator who has made the most significant published contribution in the year preceding the annual meeting of the American Institute of Nutrition, or who has published a series of contemporary papers of outstanding significance. The award will be presented at the institute's annual meeting.

As a general policy, the award will be made to one person; however, if in the judgment of the jury of award an injustice would otherwise be done, it may be divided among two or more persons. Normally, preference will be given to research workers in the United States and Canada, but investigators in other countries, especially those sojourning in the United States or Canada for a period of time, are not excluded from consideration. Membership in the Institute of Nutrition is not a requirement for eligibility and there is no age limitation.

Nominations may be made by anyone. Nominations for the 1956 award, accompanied by data relative to the accomplishments of the nominee, must be sent *before 1 Jan. 1956* to the chairman of the nominating committee, Dr. Otto A. Bessey, Department of Biochemistry and Nutrition, University of Texas Medical Branch, Galveston, Tex.

■ The School of Mathematics of the Institute for Advanced Study will allocate a small number of grants-in-aid to gifted young mathematicians and mathemati-

cal physicists to enable them to study and to conduct research at Princeton during the academic year 1956-57. Candidates must show evidence of ability in research comparable at least with that expected for the degree of doctor of philosophy. Blanks for application may be obtained from the School of Mathematics, Institute for Advanced Study, Princeton, N.J., and are returnable by 1 Jan. 1956.

■ The National Wildlife Federation has announced the availability of a series of graduate fellowships and undergraduate James Hopkins scholarships in conservation education for 1956-57. Applications for these fellowships and scholarships must be on file at the office of the National Wildlife Federation, 232 Carroll St., NW, Washington 12, D.C., by 31 Dec. Applications must show approval of the project by the head of the department in which the work is to be carried out.

These fellowships and scholarships are supported in part by the sale of the Wildlife Stamps issued annually by the National Wildlife Federation, by a permanent grant yielding a limited endowment, and by other income available to the federation, the amount of which cannot be determined before the beginning of the year. Awards granted in the past have ranged from \$500 to \$1000.

■ In the first decade of its existence the Life Insurance Medical Research Fund has given more than \$7 million for research in heart and circulatory diseases. Support has been given to 247 research programs and 302 fellowships. Grants and fellowships have aided research in 110 medical colleges, hospitals, and other institutions in the United States and Canada. The awards for 1955 total \$929,400, a record high. This includes \$816,200 for 66 research grants and \$113,200 for 27 fellowships.

The Life Insurance Medical Research Fund was organized in 1945 by several life insurance companies as a means of making joint contributions to medical research; it was the first agency to devote all of its resources to the support of heart research.

During the recent 10th anniversary luncheon, it was pointed out that results in the past 10 years have been encouraging. Fruitful means of attacking heart problems have been found, whereas 10 years ago a defeatist attitude was prevalent. In 1945 few scientists were interested in studying heart disease; today a large number of experts are at work in the field.

The speakers at the anniversary luncheon included Alan Gregg, vice president of the Rockefeller Foundation, and Francis R. Dieuaide, scientific director

of the fund. Dieuaide described a survey of current activities of 100 fellows whose awards were given 5 years ago and longer. About 60 percent are still engaged in research. Many of the remaining 40 percent have become heart specialists.

It also was announced at the luncheon that C. Sidney Burwell, professor of research medicine at Harvard Medical School, will be chairman of the fund's Scientific Advisory Council for 1955-56. There are three new members of the council: Louis S. Goodman, professor of pharmacology at the University of Utah; Henry A. Lardy, professor of biochemistry at the University of Wisconsin; and W. Barry Wood, Jr., vice president of Johns Hopkins University.

A full account of the work of the fund appears in the *Tenth Anniversary Report*. Copies may be obtained from the Scientific Director, Life Insurance Medical Research Fund, 345 E. 46th St., New York 17.

■ The National Institute of Mental Health has announced that 15 Dec. is the closing date for filing applications for grants under the National Mental Health Act for the year beginning 1 July 1956. Grants are made in support of training programs in psychiatry, clinical psychology, psychiatric social work, and psychiatric nursing. Applications may also be made by university training centers for the support of career teacher programs for the preparation of teaching personnel in the mental health disciplines.

The deadline date for filing applications for the support of pilot and evaluation studies proposing new methods of teaching, or evaluation of teaching and training methods in the mental health disciplines, is 15 Jan. 1956. Application forms and details regarding the types of support available may be obtained from the Chief, Training and Standards Branch, National Institute of Mental Health, Bethesda 14, Md.

■ The Social Science Research Council has announced the fellowships, grants-in-aid, and other appointments to be offered in 1956. Except as otherwise noted in the descriptions of certain programs, applications should be filed *not later than 9 Jan. 1956*, and awards will be announced on or about 2 Apr. 1956. Applications received after the closing date will receive attention only if time permits after consideration has been given to those previously filed. Fellowships and grants will be awarded only at the stated times, so that all applicants may compete on an equal basis.

Prospective applicants should obtain from the council the necessary application forms and detailed instructions well in advance of the closing date. In re-

questing these, it is essential to state age, place of permanent residence, academic status, present position or activity, and vocational aims; and to indicate briefly the nature of the training or research for which support is sought. Without all this preliminary information, it is often impossible to determine whether or not an application would be technically acceptable and, if so, which of several types of forms should be furnished. Needless correspondence can be avoided by careful compliance with this request. All communications should be addressed to the Social Science Research Council, 726 Jackson Place NW, Washington 6, D.C.

■ The National Foundation for Infantile Paralysis has announced that 151 students have been awarded scholarships to complete their study in physical therapy. These are in addition to 11 who received scholarship awards previously made in 1955.

The total number of physical therapy scholarships awarded by the National Foundation since 1942 is now 2365, for which almost \$3 million has been appropriated to date. The present scholarship students are residents of 34 states, the District of Columbia, and the Territory of Hawaii; they are studying in 25 schools of physical therapy.

In the Laboratories

■ A new section on animal care has been organized at Lakeside Laboratories, Inc., pharmaceutical firm in Milwaukee, Wis. Chief of the new section, which has been set up within the pharmacology division, is Ellsworth E. Thebert, veterinarian who recently joined Lakeside. He heads a staff of seven men.

■ The Southwest Research Institute, San Antonio, Tex., has announced the creation of a new electrical engineering department that will assume responsibility for certain research areas formerly included within the organization's physics department. Chairman of the new department will be William A. Mussen, supervisor of research and development in geophysics, electronic subminiaturization, ordnance instrumentation, and industrial process equipment design.

■ The Shell Chemical Corporation recently held a dedication ceremony for its new allyl chloride and chlorohydrins plant at Norco, La. The new plant makes Shell the country's largest supplier of glycerine. Two years ago the concern was making about one-fifth of the United States' output, it is now making more than one-third.

Further expansion of the plant is planned. The first addition, construction

of which will begin soon, will be a unit designed to make more than 30 million pounds a year of hydrogen peroxide. Ultimately, an acrolein unit and a unit designed to produce glycerine by an entirely new process utilizing hydrogen peroxide and acrolein will be built.

■ The Atomic Instrument Company, Cambridge, Mass., has acquired controlling interest in Kaye Development Company, Inc., South Norwalk, Conn., manufacturer of electronic color evaluation instruments and related detection devices.

■ The Hercules Powder Company has announced plans to enter a new field of chemistry with the construction of a plant at Parlin, N.J., for the production of a new type of high molecular weight polyethylene that is to be called Hyfax. The plant will have an annual capacity of approximately 30 million pounds.

The company has been licensed to use the Ziegler process for the low-pressure polyethylene. Although the new facilities will not be completed until late next year, Hercules expects to be able at the start of 1956 to distribute enough of the new-type polyethylene to permit orderly marketing of small tonnages.

This introductory material will be obtained under an arrangement with the Farbwerke Höchst AG in Germany. Höchst, one of the first companies to be licensed by Ziegler, is completing its commercial plant and will be in production in Germany early in 1956. Under its contract with Höchst, Hercules Powder Company will be able to eliminate the customary pilot-plant stage and immediately begin construction of a commercial plant.

The two contracts, one with Ziegler and the other with Höchst, climax more than 2 years of negotiations, engineering and research, and market analysis conducted by Hercules. The contract with Höchst also calls for continuing exchange of research information between the two companies.

Miscellaneous

■ The U.S. Civil Service Commission, in an effort to recruit a greater number of college-caliber people for careers in the Federal service, has introduced major changes in its college-level recruitment program. The new program, developed as a part of long-range plans to strengthen the career service, provides for a regular, balanced intake of college graduates at the entrance level in a wide range of occupational fields.

A number of civil service examinations previously open at the college level have been consolidated into a single Federal

Service Entrance Examination that was opened for receipt of applications on 18 Oct. Under this program, the student who applies will be required to take only one examination, which will be appropriate for the great majority of the entrance-level positions in the Federal service.

The Federal Service Entrance Examination is open to all college seniors and graduates regardless of the field of major study and to college-caliber people who have had equivalent experience. However, students interested and qualified primarily in engineering and the physical sciences will continue to be recruited through separate examinations that do not require a written test.

The first written test for the Federal Service Entrance Examination will be held on 10 Dec. for those who apply by 18 Nov. Additional written tests will be given every few months or as the needs may require; applications will be received until further notice. Interested persons may obtain copies of the examination announcement and application forms from the U.S. Civil Service Commission, Washington 25, D.C.

■ *Summary of Survey of Philanthropic Foundations*, a 32-page pamphlet that is excerpted from the seventh edition of *American Foundations and Their Fields*, by Wilmer Shields Rich, is available from the American Foundations Information Service, 860 Broadway, New York 3.

■ A memorial scholarship in botany is being established at Butler University in memory of the late head of the botany department and recent president of the Ecological Society of America, John E. Potzger. Checks payable to the J. E. Potzger Memorial Scholarship Fund should be sent to the Botany Department, Butler University, Indianapolis 8, Ind.

■ A special grant from the Rutgers Research and Endowment Foundation, together with the cooperation of the Williams and Wilkins Company and the Rutgers University Press, has made it possible to offer copies of the following books by S. A. Waksman for free distribution to established libraries, hospitals, and other institutions: *Streptomycin*, *Nature and Practical Applications* and *Literature of Streptomycin*. Requests should be addressed to R. A. Day, Librarian-Editor, Institute of Microbiology, Rutgers University, New Brunswick, N.J.

■ Applications are now open to college and university faculty members for places in the Oak Ridge research participation program for 1956. Administered by the Oak Ridge Institute of

Nuclear Studies in cooperation with Oak Ridge National Laboratory, the program is designed to disseminate scientific and technical information to educational institutions by enabling faculty members to spend varying amounts of time—usually the three summer months—conducting research in Oak Ridge laboratories. The participant's Oak Ridge salary approximates his university salary.

Applications for 3-month summer appointments in 1956 should be in the hands of the University Relations Division, Oak Ridge Institute of Nuclear Studies, Box 117, Oak Ridge, Tenn., by 15 Dec. Notifications of appointment will be made by 15 Feb.

■ In recognition of the 400th anniversary of the death of Georgius Agricola (Georg Bauer), German scholar and scientist, on 21 Nov., the November issue of *The Scientific Monthly* includes a portion of the introduction to Agricola's classic work, *De Re Metallica*, that was translated from the Latin in 1912 by Herbert C. and Lou H. Hoover. The cover illustration of this issue is a reproduction of one of the woodcuts that appeared in *De Re Metallica*.

Among the other articles included in the November issue are "Pan-Indian culture of Oklahoma," James H. Howard; "Lost art of strad varnish," Joseph Michelman; "Structure of a classic raw material," H. H. Bosshard; "Modern science and refutation of the paradoxes of Zeno," Adolf Grünbaum; "Radiocarbon dating in the light of stratigraphy and weathering processes," Charles B. Hunt; and "The garter snake," Charles C. Carpenter. Sixteen books are reviewed.

■ The South Asia Science Co-operation Office of the United Nations Educational, Scientific and Cultural Organization has been producing a *Bibliography of Scientific Publications of South Asia* (India, Burma, Ceylon) since 1949 and thus far 11 issues have been printed. Although this bibliography has been distributed to many libraries throughout the world, it is felt that there still may be some libraries that would like to receive the work. A fairly large number of back issues are available from the UNESCO South Asia Science Co-operation Office, C.S.I.R. Bldg., Old Mill Rd., New Delhi 2, India.

After issue No. 12 of the Bibliography, which will complete the year 1954, a new arrangement will be put into effect under which the Science Co-operation Office will continue to prepare the material but printing and distribution will be undertaken by the Indian National Scientific Documentation Centre. When the new plan is instituted, it will be necessary to charge for the publication. The cost will be Rs. 10 per year covering 4 parts.

National Academy of Sciences

Abstracts of Papers Presented at the Autumn Meeting, 2-4 November 1955, California Institute of Technology, Pasadena

Stellar Magnetism, a Summary

The gradual accumulation of magnetic data on the sharp-line peculiar A-type stars over an interval of 9 years now permits a classification of these objects into four closely related groups, depending on the main characteristics of the magnetic variation: (i) 1-week magnetic reversers of large amplitude; (ii) slower, quasi-periodic variables; (iii) rapid irregular fluctuators; and (iv) slow irregular fluctuators.

The four stars of group (i) show reversing magnetic fields of large and nearly identical amplitude, with remarkably similar periods; all are of spectral type AOp. The slower variables of group (ii) have ultra-sharp lines, later spectral types (FOpm), and cycles ranging up to 226 days. A majority of the magnetic stars, being irregular, fall into groups (iii) and (iv). Again, the slower fluctuators tend to have the sharper lines and generally later spectral types. The outstanding spectrum variables are confined to groups (i) and (ii) and to a group (i') of short period, with lines too broad for measurement of the Zeeman effect.

Intrinsic hydromagnetic fluctuations evidently occur in the surface layers of most of these stars. A beginning can be made on the interpretation of these results by analogy with the solar magnetic cycle and the hydromagnetic processes observed in some detail on the sun. The enhanced magnetic activity observed among stars of spectral type A and early F is in accord with the "dynamo theory" of Elsasser, which requires both rapid axial rotation and the action of Coriolis forces on convective material. Stars of earlier type do not have hydrogen convective layers; those of later type do not rotate rapidly.

HORACE W. BABCOCK
Mount Wilson and Palomar Observatories

New Long-Period Waves Recorded with a Strain Seismograph

A seismogram of the Kamchatka earthquake of 4 November 1952 written by an electromagnetic strain seismograph having a galvanometer of 3 minutes period has revealed three waves or oscillations not previously known. These include a wavelet identified as P_R, a Rayleigh wave gen-

erated at the antipodal point; a long-period wavelet of approximately 50 minutes period; and a still longer period pulse of many hours' duration. The long-period wavelet may represent a free vibration of the earth, whereas the long-period pulse may be the readjustment of the world strain pattern in response to the strain relief at the source.

HUGO BENIOFF
Seismological Laboratory,
California Institute of Technology

Single Quartz Crystal Point-Focusing X-ray Monochromator

A point-focusing x-ray monochromator that uses Bragg reflection from a single lamina of quartz bent in such a way that its atomic planes are given two principal radii of curvature has been constructed for use in low-angle diffraction studies. It was found that the crystal reflects 2.78 percent of the incident Cu K α radiation into a converging beam 1 m long, with a resolution of better than $\frac{1}{2}$ mm, except for a very faint halo. The instrument has been used to obtain diffraction patterns from normal and sickle-cell human hemoglobin and also from southern bean mosaic virus. The speed of the present instrument is roughly 200 times that of the equivalent pinhole collimating system. A similar but still faster instrument is being constructed.

This research was sponsored by the U.S. Atomic Energy Commission and the Office of Naval Research.

DWIGHT W. BERREMAN
California Institute of Technology
Present address: Stanford Research Institute

On the Method of Lighthill

In a paper ["A technique for rendering approximate solutions to physical problems uniformly valid, *Phil. Mag.* 40, 1179 (1949)] M. J. Lighthill obtained formal expansions in powers of the parameter α of the solutions of differential equations of the form $(x + \alpha u) \frac{du}{dx} = r(x) = u q(x)$ which satisfy an initial condition $u(1) = a$. Essential to the method is the fact that in order to obtain approximations useful in the neighborhood of $x = 0$

both the independent variable x and the dependent variable u are expanded in powers of α . W. A. Wasow showed that under certain conditions on $r(x)$ and $q(x)$, as well as on the solution of limiting equation $x \frac{du}{dx} = r - uq$, these expansions were convergent. In the present paper the convergence is discussed for more general equations, removing unessential assumptions.

H. F. BOHNENBLUST
California Institute of Technology

Retention and Properties of S³⁵-Labeled Hemocyanin in the Livers of Normal and Immunized Rabbits

The S³⁵ label of soluble sulfanilic-azohemocyanin antigen is detectable in the livers of injected animals for at least 4 months after a single intravenous injection or after the last of a series of nine injections. Preliminary data suggest that less antigen persists in livers of animals that received multiple injections than in those that received only a single injection. An initial injection of labeled antigen, followed by several injections of unlabeled antigen results in a rapid loss of labeled antigen from livers when the concentration of circulating antibody reaches about 100 μ g/ml of serum. The retained antigen rapidly loses its ability to form insoluble complexes with precipitating antibody but retains its ability to combine with antibody and to form soluble complexes. The physical properties of the retained antigen are different from those of the injected material. It is suggested that perhaps these antigen fragments that are retained are the actual templates that are involved in antibody formation.

DAN H. CAMPBELL
JUSTINE S. GARVEY
California Institute of Technology

Alpha-Particle Decay of Heavy Nuclei

Recent experiments by Asaro and Perlman on the energies and intensities of alpha-particles emitted by heavy nuclei show systematic trends with atomic number in the intensities of the fine structure components leading to excited states of the daughter nuclei. These excited states have been interpreted as the rotational excitations of the (ellipsoidal) nucleus according to the ideas of A. Bohr and others. The alpha-particle intensities to these states can then be interpreted in terms of the angular distribution of the alpha-particles relative to the orientation of the symmetry axis of the ellipsoidal nucleus. The present work concerns a new formulation of the classical (WKB) approximation suitable for the treatment of the penetration of alpha-particles through a nonspherical barrier in a nonspherical potential. It is found that the amplitude for barrier penetration in any direction can be viewed as a result of tunneling outward along the direction of steepest descent with the appropriate exponential decrease in amplitude, together with a transverse

diffusion process that is the counterpart of the usual centrifugal barrier.

As a result of calculations by this method, it is found that the systematic decrease with Z of the intensity of the $l=4$ component in the alpha-particle angular distribution may result from a corresponding systematic growth in a P_4 distortion of the nuclear surface. Such a distortion of negative sign and amplitude only 3 or 4 percent of the nuclear radius can lead to a vanishing $l=4$ component in the alpha-decay spectrum.

This work was assisted by the joint program of the U.S. Office of Naval Research and the Atomic Energy Commission.

ROBERT F. CHRISTY
California Institute of Technology

Formulas for Pressure on Cones at Supersonic Speed

Formulas are given for calculating the pressure on slender cones at zero incidence in supersonic flow. A different formula is given for each of the speed ranges, transonic, supersonic, and hypersonic. An estimate of the ranges of cone angle and Mach number in which the formulas can be used is given, together with estimates of the error incurred.

J. D. COLE
California Institute of Technology

Delayed Effects of Mutagenic Agents

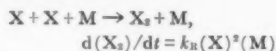
The detection of mutagenic effects from radiation, atomic fallout or chemical agents may not always be as simple as might at first appear. It can reasonably be expected that there will always be some mutations, whether induced or spontaneous, which will find expression only in the presence of a special combination of already established genes, or simultaneous mutations whose effects will be mutually contingent on one another. In either case somatic appearance of a trait in which a fresh mutation is involved is likely to be considerably delayed.

This aspect of the matter is considered in a study of the descendants of mice that have been subjected to a single treatment with nitrogen mustard, a commonly employed mutagenic agent. Some of the descendants have shown deviations that suggest simple mutational changes (such as pink eyes or extra teeth) that can be analyzed in the usual way. Others (such as syndactyly and some visceral anomalies) are more complex and occur in what at first sight might seem to be an erratic fashion. Many of the latter are presumably due to cumulative effects of several initially independent but mutually interacting genes which can be brought into effective relationship only after several generations. A significant inference from the study is that genetic tests extending over no more than two or three generations are by no means adequate for detection of all the mutations that may have occurred as a result of any single treatment.

C. H. DANFORTH
Stanford University

Study of Atomic Recombination Reactions by Shock Waves and by Flash Lamps

The rate of the bimolecular atomic recombination process



can be measured at room temperature by the flash photolysis method. In the foregoing equation, X represents a halogen atom and M any gas molecule. The rate at high temperatures can be computed from the rate of the reverse dissociation reaction as measured by the shock-wave method.

As a result of work in several laboratories, the present status of our knowledge of the foregoing reaction is the following: When X is iodine and M is argon, $k_{r,A} = 2.2 \times 10^9$ lit² mole⁻² sec⁻¹ at 300°K and 0.5×10^9 at 1200°K. When M is molecular iodine itself, $k_{r,I_2} = 1.3 \times 10^{10}$ at 300°K and is less than 1.5×10^{10} at 1200°K. The remarkable efficiency of iodine as a third body at room temperature is presumably due to the transient formation of I_3 . The decrease in the ratio $k_{r,I_2}/k_{r,A}$ with increasing temperature is presumably due to the thermal instability of I_3 .

It is now clear that, in general, k_r increases with increasing molecular complexity of M and decreases with increasing temperature. An attractive hypothesis that requires further investigation is that the negative temperature coefficient of k_r is greater, the greater the value of k_{r,I_2} itself.

The available results for X being bromine are also in agreement with the foregoing statements.

N. DAVIDSON, D. BRITTON, D. BUNKER G. SCHOTT, W. GEHMAN
California Institute of Technology

On the Character of Differential Equations Representing Wave Propagation

Partial differential equations for functions of space and time represent propagation phenomena if they are of the hyperbolic type. The distinction between hyperbolic and other types is easily formulated, except in cases when the "characteristic elements" are multiple. Since such multiplicities do often occur in physics and mechanics, it is important to clarify this situation. Such clarification is indicated in the paper. Various phenomena such as Huyghens' principle are connected with this subject.

R. COURANT
New York University

A Protein Whose Configuration Is Controlled by a Specific Cofactor

Some strains of bacteriophage must be activated by cofactor before they can adsorb to their bacterial hosts. Up to the present time, the only compounds shown to possess cofactor activity have been certain amino acids and amino acid analogs. It is shown [G. Sato, thesis, California

Institute of Technology (1955)] that urea, a well-known denaturing agent, is capable of activating cofactor requiring phage. Urea also kills the phage. Experiments are performed to characterize the properties of urea-activated phage, in regard to stability of urea-induced adsorbability and in regard to adsorption rate. The kinetics of the urea-activation process and of the urea-killing process have been studied in detail. Both processes depend on concentration of urea, temperature, and pH in a manner similar to denaturation of protein by urea.

It is concluded that urea effects the activation of phage by changing the configuration of the protein of the phage-adsorption organ. It is further postulated that the action of cofactors consists in a change in the configuration of phage protein.

It is suggested that many other pharmacological phenomena involve the reversible changes of configuration of a protein that is capable of existing in several states, the equilibrium between these states being strongly dependent on changes in concentrations of specific substances of low molecular weight.

MAX DELBRÜCK
California Institute of Technology
GORDON SATO
University of California, Berkeley

D-alpha-Hydroxy Acids in Biological Systems

It has been shown in our laboratory that D-lactic acid is an essential metabolite for *Lactobacillus casei* 280-16, a mutant of the wild form of *L. casei*, and that the activity of yeast extract, butter, and wool wax appears to be due largely to their content of D-lactic or other D-alpha-hydroxy acids. It has been reported that yeast and brain cerebrosides (2-hydroxytetraacosanoic, 2-hydroxyhexacosanoic, and 2-hydroxydocosanoic acids), the alpha-hydroxy acids from wool wax, and 2-hydroxypentadecanoic acid (derived from ustilic acid) are of the D-configuration.

Active compounds include the alpha-hydroxy derivatives of the following DL-acids: butyric, capric, caproic, caprylic, lauric, myristic, valeric, mandelic, and phenyllactic acids. Inactive compounds include beta-hydroxy acids, alpha-keto acids, and alpha, beta unsaturated acids. Of the nine DL-1,2-alkanediols studied dodecanediol markedly stimulated the growth of *L. casei* 280-16 in hydroxy acid-free medium, whereas tetradecanediol and hexadecanediol markedly inhibited growth in a DL-lactic acid-containing medium.

It has been concluded from this work that alpha-hydroxy acids of natural lipids are predominantly of the D-configuration, may serve as metabolic precursors to long-chain D-alpha-hydroxy acids of essential lipids, and may play some role in the nutrition of mammals as well as bacteria. An over-all mechanism has been proposed for the formation and utilization of D-alpha-hydroxy acids.

M. S. DUNN, M. N. CAMIEN, E. GELLER
University of California, Los Angeles

Singularities of Axially Symmetric Potentials

A generalized axially symmetric potential (s.p.) is a solution of the partial differential equation $u_{xx} + u_{yy} + ky^{-1} u_y = 0$, which is an even function of y and a regular function of x and y for sufficiently small y and some x . An s.p. is uniquely determined by its (analytic) values on the x -axis. Given an analytic function of x , regular on some interval of the x -axis, the s.p. that reduces on the x -axis to the given function will be regular in a unique maximal simply connected region in the x, y plane which is convex in the y direction. The main result of the study is that the maximal region of regularity is independent of k (that is, of the number of dimensions).

A. ERDÉLYI

California Institute of Technology

Active Metal Intermediates in Coulometric Analysis

Coulometric titrations performed with constant-current techniques involve the production of chemical reagents by electrolysis. If a reagent is generated with current efficiency of 100 percent, the time of electrolysis is an exact measure of the amount of substance titrated.

Some active metals can be deposited quantitatively by electrolysis. After a metal deposit has reacted chemically with an oxidizing agent in solution, the excess metal can be stripped off electrolytically. With constant current, the difference between depositing and stripping time is proportional to the amount of oxidant in the sample.

Copper metal has been plated from cuprous halide solutions and has been used to titrate cupric copper and ferric iron samples with good analytic accuracy. In order to produce a more powerful reducing agent, metal amalgams are being prepared and decomposed electrolytically. Zinc and cadmium systems have been investigated, and studies on other amalgams are in progress.

PAUL S. FARRINGTON

University of California, Los Angeles

Synthesis of the Elements in Stars

The nuclear reactions by which the stable elements may be synthesized from hydrogen in stellar interiors have been enumerated and studied in some detail. The results lend support to the hypothesis that a process of continuous synthesis as stars evolve, eject material into interstellar space, and recondense may be the source of the observed universal abundances of the elements.

On this point of view, helium is formed by hydrogen burning in main sequence stars. The nuclei C^{12} , O^{16} , and Ne^{20} are formed from helium in the condensed, hydrogen-exhausted cores of red giant stars. The eventual exhaustion of the helium leads to reactions among still heavier

nuclei, with the ultimate formation of the most stable nuclei, those of the metallic elements (Ti to Zn with a maximum at Fe^{56}). In second generation stars, hydrogen and helium reactions with the C^{12} , O^{16} , and Ne^{20} produce the stable isotopes of these nuclei as well as of N and F. In the giant stage, the interaction of helium with the nuclei C^{12} , O^{16} , and Ne^{20} leads to the production of neutrons. If large proportions of the metals are present, as in Population I stars, the neutrons are captured by the metallic nuclei at thermal energies of ~ 15 kev leading to the successive synthesis of the heavy elements up to Pb. Where the metals are rare, as in Population II stars, capture of the neutrons by the light elements leads to the synthesis of the intermediate elements from Na to Ti.

D, Li, Be, B and the natural radioactive alpha-emitters cannot be produced in stellar interiors and are possibly synthesized in "spots" on the surfaces of variable magnetic stars by a low-energy component (10 to 100 Mev) of the cosmic radiation produced in these spots. Critical tests of the synthesis mechanism proposed will depend on more accurate and extensive measurements of the cross sections of the nuclear reactions involved.

This investigation has been made in collaboration with G. R. and E. M. Burbidge and follows in large measure the work of E. E. Salpeter, F. Hoyle, and A. G. W. Cameron.

WILLIAM A. FOWLER

California Institute of Technology

Evolutionary Trends in Abundances of the Chemical Elements

During the last few years various aspects of the theory of nuclear transmutation in stars have been developed. Astrophysical estimates of the composition of peculiar and normal stars confirm some of these predictions and make it possible that the heavy-element content of our galaxy has changed appreciably.

Thermonuclear processes in the main-sequence stars result in a secular increase of the He/H ratio and a change in the C/N and C^{12}/C^{13} ratios. At higher central temperatures C, O, Ne, Si, and so forth, can be formed by alpha-particle reactions. In addition, a surprisingly large supply of neutrons comes from $C^{13}(\alpha, n) O^{16}$, and may build heavier elements. Certain reactions may occur at the surfaces of the stars.

Some examples of types of stars that show all the afore-mentioned effects will be given. Stars of low luminosity, recently found at Palomar, show convincing enhancement of both He and N. The most startling effect is the presence of Tc, discovered by Merrill in certain red giants, which has a half-life of only 300,000 years.

Modern astrophysical theories suggest that stars are being formed out of interstellar gas. Recent observations have shown that various types of old stars (Population II) are losing matter into space. Newly formed stars of Population I can be expected to show higher abundances of the

heavy elements. Observations of spectra of subluminescent stars of Population II confirm this prediction. Abundances in the earth and sun represent a relatively late state of evolution of the elements.

JESSE L. GREENSTEIN

Mount Wilson and Palomar Observatories

Structure of Human Intellect

Multiple-factor theory provides a convenient model for the description of human abilities in terms of a set of vectors in n dimensions. Analysis of individual differences among young, superior adults shows that at least 40 dimensions are required to account for the patterns of intercorrelations among scores from tests involving intellectual tasks.

The intellectual factors show a strong tendency to fall into a system, including a small group of memory factors and four groups of thinking factors. The thinking-ability factors can be distinguished, first, as cognition (discovery) abilities, action (production) abilities, and evaluation abilities. The action abilities can be further differentiated in terms of convergent thinking and divergent thinking.

Within each of the five groups, there is a common tendency for factors to come in sets of three parallel factors, depending on the test content—perceived figures, structural elements (such as letters or numbers), and meanings (concepts or ideas).

A survey of the factors in such a system indicates a number of vacant cells where possibly undiscovered factors exist. With such vacancies filled, the number of intellectual factors would approach 60. The implications for the psychology of thinking and for the practice of intelligence testing are very significant.

J. P. GUILFORD

University of Southern California

Nuclear Energy Levels

The conspicuous success of atomic spectroscopy in revealing the structure of the atom justifies the expectation that the analogous study of nuclear spectroscopy may be of comparable utility in elucidating the structure of atomic nuclei. Presently available information on the energy levels of light nuclei is sufficiently detailed to make it clear that the problem is one of much greater complexity than might have been thought but, nevertheless, gives considerable hope that some features at least can be understood. Unlike the atomic case, the energies of nuclear-excited states do not appear to admit expression in any simple mathematical form; spacings between levels in light nuclei may vary from some millions down to some thousands of electron volts, with considerable individual deviations from a general tendency for smaller separations at higher excitations. On the other hand, a striking feature is observed in the close similarity between energy-level arrangements in isobars, suggesting that it is the total number of particles in a nucleus that determines its structure rather than the somewhat incidental nuclear charge. Thus, whereas the

nuclear spectra of Li^7 and Be^9 correspond in all essentials, those of Li^7 and Li^6 are entirely different. This observation, which has been confirmed for many isobaric sets, has an important bearing on the theory of forces between the neutrons and protons that make up the nucleus.

Other information derived from energy-level studies indicates that the concept of a "shell" structure, which has had conspicuous success in accounting for many features of the normal states of nuclei, may have useful applications in the excited states as well. Attempts to associate known energy levels with those predicted by this model constitute an important fraction of current work in the field.

This work was assisted by the joint program of the U.S. Office of Naval Research and the Atomic Energy Commission.

T. LAURITSEN
California Institute of Technology

Energy of Earthquakes

Gutenberg and Richter have revised equations that permit the calculation of earthquake energy E (in ergs), probably within 1 unit of $\log E$. I find that in the average year 1904 to 1954, $\log E = 25.0$; the energy released in earthquakes is less than 1 percent of that released in the earth by radioactive processes. At all focal depths h , the frequency of earthquakes releasing a given energy E decreases nearly exponentially with increasing E . The average annual number of shallow shocks ($h \leq 60$ km) in a range of $\frac{1}{4}$ unit of $\log E$ increases from 0.04 for the largest known ($\log E = 25.2 \pm$) to several hundred thousand producing motion near the epicenter barely above the usual unrest of the ground ($\log E = 10.0 \pm$). About two-thirds of all energy is released in the crust above 35 km, only 3 to 4 percent below 300 km. Shocks originating deeper than 300 km are known in the relatively narrow circum-Pacific and Alpine belts only; there the energy release has a minimum at depths near 300 km and secondary maxima near 350 to 400 and 550 to 650 km. With increasing h , the maximum energy E^* found for a single shock decreases:

h	20	150	350	650	720 km
$\log E^*$	25.2	25.0	24.5	23.8	22.6

No shocks are known below 720 km; this could be caused by decrease of the apparent viscosity coefficient from 10^{23} to 10^{20} poises in the crustal layers to about 10^{10} poises below 700 km.

BENO GUTENBERG
Seismological Laboratory,
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Energy Characteristics of Strong-Motion Earthquakes Pertinent to the Design of Structures

The engineering problem of designing structures to resist strong earthquake ground motion requires some reliable method of estimating the amount of strength required by a structure to enable it to withstand earthquake motion.

Such a method must take into account the statistical aspects of the problem based on recorded data of past earthquakes, and also the influence of the physical properties of the structures it is proposed to build. For linear structures with multiple degrees of freedom it is found from recorded strong ground motions that the spectrum of the maximum vibrational energy per mode exhibits certain characteristics from which can be established an upper bound for the maximum vibrational energy that the structure as a whole can experience. The properties of the upper bound are such that for structures of the type usually encountered in practice the maximum energy input is independent, in a statistical sense, of the structural strength and stiffness and depends in a simple way on the mass and damping of the structure. A suggested criterion for designing a structure is that it be able to absorb the maximum energy input, either elastically or plastically, without failure. This leads to results differing from those given by design procedures currently in use. Comparison with observed behavior of structures during earthquakes indicates satisfactory agreement with the results computed by this method.

GEORGE W. HOUSNER
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Energy Transfer Processes in Unimolecular Reactions

The Lindemann (1922) mechanism of unimolecular reactions consists of three different physical processes: activation by collision, deactivation by collision, and reaction of isolated activated molecules. The process of activation by collision may be expressed (Tolman, 1926) in terms of Boltzmann factors and the process of deactivation by collision. A given model of the activated molecule and the reaction process (for example, Rice, Ramsperger, Kassel, 1927; Glasstone, Laidler, Eyring, 1940; N. B. Slater, 1938-53; Marcus, 1952) gives rise to the Boltzmann factors and reaction rates of excited molecules; entirely separate physical considerations are required for the problem of energy transfer by collision.

In quantitative applications of the usual theories, use is made of Tolman's crude order-of-magnitude approximation; that is, deactivation occurs upon every collision. However, use can be made of the Lindemann mechanism in its sum-over-state form in which the probability function and the reaction function are left completely general and unspecified. Several general statements can be made concerning the energy-transfer function in terms of observed reaction-rate data. Tests of these general theorems against experimental data indicate that deactivation does not occur upon every collision, that the rate of deactivation varies with the degree of activation of the reactant molecule, and that this variation with degree of excitation is different from one foreign gas to another.

HAROLD S. JOHNSTON
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Coordination of Alkynes with Silver Ion

The reaction of 3-hexyne with aqueous silver nitrate at different concentrations but all at unit ionic strength was investigated by a distribution method in which the organic solvent was carbon tetrachloride. A plot of the equilibrium constant against silver-ion concentration has a slight upward curvature, indicating that the principal complex is Un.Ag^+ (where Un represents an alkyne) and a minor complex is Un_2Ag^+ . The respective constants are $K_1 = 19.1$ and $K_2 = 0.22$. Since these constants are calculated from concentrations, they are not thermodynamic constants.

The change in solubility of a number of alkynes in aqueous solutions at $\mu = 1$ with a rise in silver-ion concentration is not linear, and again the plots have a slight upward curvature. Here also a second complex is involved. By the method of least squares, values of K_1 and K_2 have been calculated. For 3-hexyne these are, respectively, 17.3 and 0.36, in satisfactory agreement with the values obtained by the distribution method.

Alkynes having methyl substituents at α -carbon atoms have constants that differ little from those of 3-hexyne. Without any trend K_1 varies from 11.9 to 23.4, and K_2 from 0.21 to 0.53 among 3-hexyne, 2-methyl-3-hexyne, 2,2-dimethyl-3-hexyne, 2,2,5-trimethyl-3-hexyne, 2,2,5,5-tetramethyl-3-hexyne and 2-heptyne.

An approximation to a thermodynamic equilibrium constant can be obtained when some simplifying assumptions are made. These constants have a definite trend and give realistic ΔH values, whereas K_1 gives unrealistic values for ΔH .

HOWARD J. LUCAS
W. SMITH DORSEY
GEORGE K. HELMKAMP
California Institute of Technology

Differential Response of Eye and Optic Pathways to Intensity and Wavelength

An attempt has been made to localize upon the eyeball of the cat the origin of the components of the electroretinogram, in particular the a - and b -waves. Through scleral slits or holes recording has been accomplished from several points on the bulbus in such a manner as to reveal by phase reversal techniques and pattern of response suggestions as to the origin of the ERG components. Variations in the stimulus parameters of intensity and wavelength have been utilized. Simultaneous recordings from the eye, optic nerve, optic tract, lateral geniculate bodies, and cortex provide differential response forms, and latencies that make it appear likely that an a -, rather than a b -, process triggers the optic nerve discharge. The possible role and origin of each of these components is discussed.

DONALD B. LINDSLEY
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Electromotive Force Centrifuge— Factors Affecting Accuracy

The electromotive force centrifuge consists of a simple galvanic cell with electrodes at radii r_1 and r_2 in a rotor that turns at a rate of n rev/sec. Under these conditions a potential E develops, which for the cell that may be represented by



is given by the equation

$$E F = 2\pi^2 n^2 (r_2^2 - r_1^2) \\ [t_K (M_{KI} - \bar{V}_{KI}) - (M_{I_2} - \bar{V}_{I_2})]$$

in which t_K is the transference number of the potassium-ion constituent, M_{KI} and M_{I_2} are molecular weights, \bar{V}_{KI} and \bar{V}_{I_2} are partial molal volumes, and ρ is the density of the solution. The phenomenon has interest since it may be used as a means of determining transference numbers particularly for electrolytes in non-aqueous solvents. Since the electrodes do not have to carry appreciable currents, as in most other methods for determining transference numbers, disturbances due to joule heat are avoided.

The early work on the emf centrifuge was done by des Coudres (1893) and by Tolman (1911). Our work at the Rockefeller Institute has been devoted largely to the attempt to make the instrument one of precision. To this end improvements have been made in the measurement of the speed of rotation, in the determination of densities of the solutions and of the partial molal volumes, and in the elimination of the effects on the potentials of suspended dust particles. It has been found that the foregoing equation must be modified for the effect of the complex formed between KI and I_2 , and an independent determination of the composition of the complex is obtained.

Recent work has been concerned with improvements in the design of the commutator connecting the rotating cell with the potentiometer, with elimination of effects resulting from uncertainties in the values of the radii, r , and studies of the adiabatic heat effects and persisting temperature gradients on the measured potentials.

D. A. MACINNES
ROBERT L. KAY

Rockefeller Institute for Medical Research

Some Properties of the Apparent Expansion of the Universe

A survey of all available observational data on the apparent expansion of the universe is made. These data consist of (i) redshifts of 620 extragalactic field nebulae and 26 distant clusters of nebulae obtained by Humason at the Mount Wilson and Palomar Observatories, (ii) redshifts of 300 field nebulae obtained by Mayall at the Lick Observatory (114 nebulae are in common with the Mount Wilson-Palomar list), and (iii) apparent magnitudes obtained by Pettit of most of these nebulae.

Discussion of this material gives the following five conclusions. (i) The data for the field nebulae show the relationship between the apparent magnitudes (corrected for Pettit's variable photometer apertures and for the selective effects of redshifts) and the log of the redshifts to be $m_c = (5.028 \pm .116) \log c \Delta\lambda/\lambda_0 + \text{const.}$ A coefficient of exactly 5 indicates a linear redshift-"distance" relationship if no general internebular obscuration is present. (ii) The mean absolute magnitude of all nebular classes, except Irr, is the same within the probable error of the data. (iii) The apparent expansion appears to be isotropic. (iv) Data for the clusters with $c\Delta\lambda/\lambda_0 > 0.1$ show an apparently significant departure from a linear expansion in the direction of deceleration. This result is not conclusively established because of uncertainties in the effects of redshifts on apparent magnitudes, the change in M_{bol} of nebulae owing to evolution, and the consequences of the Stebbins-Whitford effect. The data, corrected with estimated values for these effects, give $\ddot{R}_0/H\dot{R}_0 = -2.6$ where R_0 is a characteristic length and H is the Hubble redshift parameter. (v) Evaluation of H gives a value of 180 km/sec 10^6 pc or $H^{-1} = 5.4 \times 10^9$ years. This value is provisional and may be uncertain by 20 percent. If \ddot{R}_0 is negative, then the "age of the universe" is less than H^{-1} .

N. U. MAYALL

Lick Observatory

A. R. SANDAGE
M. L. HUMASON

Mount Wilson and Palomar Observatories

Neural Basis of Bilateral Perceptual Integration

Extensive sensory, motor, and psychological tests have failed to demonstrate any clear-cut functional deficiencies following complete surgical section or agenesis of the corpus callosum in man. The findings are difficult to understand in view of the very large size of this tract and the fact that it serves as the principal connection between the cortices of the two hemispheres.

In recent experiments with cats it has been possible to demonstrate a definite function for the corpus callosum in mediating the transfer of perceptual data from one side of the brain to the other. In these experiments the crossed optic fibers were destroyed at the optic chiasma, thereby restricting the visual input from the two eyes to their respective brain-halves. The left hemisphere then received retinal impulses from only the left eye, and the right hemisphere from only the right eye. After the cats had been taught simple pattern discriminations with a mask covering one eye, the mask was shifted to the opposite eye. Transfer of the learned discrimination to the untrained eye was almost perfect with the callosus intact but was entirely absent in cases in which the corpus callosum had been sectioned prior to training. Indeed, with the corpus callosum divided, completely conflicting responses could be

established with the two separate eyes with no evidence of interference. Further work indicates that visual transfer can still occur when as little as 20 percent of the total cross-sectional area of the corpus callosum is left unsectioned at the posterior end. Conversely transfer fails when the posterior half or more is transected.

RONALD E. MYERS

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NGC 1275, an Example of Colliding Galaxies

Several radio-sources have now been identified with colliding galaxies. Only weak nonthermal radio emission results from a close approach of two galaxies, which may lead to spectacular tidal distortion. Very strong emission is produced only by a direct collision. Only one of the sources of this type, NGC 1275, is of sufficient apparent size to permit a detailed investigation.

Spectroscopic observations, guided by photographs by Baade with various plate-filter combinations, show that the object consists of two galaxies, a tightly wound spiral of early type, and a highly distorted spiral of late type. North of the nucleus the late-type system is seen in front of the early-type system. A low excitation emission spectrum with double lines indicates that the late-type galaxy moves with a radial velocity of about 3000 km/sec toward the early-type galaxy. Near the nucleus and farther to the south, this spectrum is replaced by a high excitation spectrum with single asymmetrical lines of great width. These results suggest that the actual collision is now in progress in the northern part of the system. The interaction in the southern part is finished but has left the now combined gas of the two systems in a highly excited, heated, and turbulent state. The equatorial planes of the two systems seem to form an angle of about 20° . The total duration of the collision then is of the order of a million years.

R. MINKOWSKI

Mount Wilson and Palomar Observatories

Transmission of Activity in the Mammalian Cortex

The usual concept of the activity of the cortex is that impulses travel along nerve fibers and over synapses from one nerve cell to another and that such guided impulses underlie the function of the cortex. The spontaneous electric activity of the cortex, shown by the electroencephalogram would represent a statistical outcome of such activity. There is an alternative concept of transmission where the electric fields of an active group of nerve cells can spread out to modify or excite other groups, and this is thought of as operating in addition to direct connectivity.

If the cortex is directly stimulated by a brief electric pulse, it gives rise to a characteristic electric discharge. This seems to be a forcing of a large number of

cells into combined activity, and this response can spread up to a centimeter or more in the rabbit cortex. When a cut is made through the cortex and the underlying white tracts connecting one area with another, the transmission of this response is blocked, except for a small potential on the opposite side. This remaining potential is roughly one-tenth the size of a regular response on the stimulated side, and the question arises whether this represents only a physical spread of current from the active side across the cut or whether it is a weak response of the cells to these electric fields. That the small potential is not such a response was shown by the failure of the excitant drug strychnine to enhance it or of spreading depression to block it.

Spreading depression is a phenomenon released by a more powerful distant cortical stimulation, which results in a wave of depression moving slowly through the cortex and blocking all activity—electroencephalographic and the cortical response. On the stimulated side of the cut, spreading depression blocks the response. On the opposite side, the small response remains. It is concluded that the small potential on the distant side of the cut represents a physical spread of activity and that this electric field is not sufficient to excite neuronal activity across the distance of a thin cut.

SIDNEY OCHS
California Institute of Technology

Theoretical Calculation of Gas Emissivities

Few experimental data are available for the total equilibrium radiant energy emitted from heated gases at moderate and elevated pressures. Although the theoretical calculation of gas emissivity has been understood since the development of the quantum theory of radiation, at least in principle, no serious efforts to determine this quantity from fundamental physical constants were published until a few years ago. The molecular parameters required at moderate temperatures (up to about 3000°K) are (i) integrated intensities for vibration-rotation bands, (ii) spectral line shapes and half-widths as functions of temperature and pressure, and (iii) adequate theoretical descriptions for relative intensities of spectral lines (within a given vibration-rotation band) and of entire vibration-rotation bands.

As the result of new experimental measurements and refinement of fundamental theoretical studies, as well as of the development of new evaluation procedures, it has become possible in practice to calculate gas emissivities. Successful computations, which are in agreement with engineering measurements of total emissivities where these are available, have been carried out for diatomic molecules and for CO₂ at moderate temperatures.

This work was supported by the Office of Naval Research under contract Nonr-220(03), NR 015 401.

S. S. PENNER
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Incorporation of the Pyrimidine Ring of Adenine into the Isoalloxazine Ring of Riboflavin

Uniformly labeled C¹⁴-adenine has been administered to cultures of *E. ashbyi*. The C¹⁴-riboflavin has been isolated, degraded, and shown to have 94 percent of the C¹⁴ limited to the pyrimidine ring of riboflavin.

The specific activities of the individual carbon atoms of the pyrimidine ring of riboflavin were quite closely related, from which it has been concluded that adenine serves as a precursor in the biogenesis of riboflavin through the contribution of an intact pyrimidine ring.

WALTER S. McNUTT, JR.
California Institute of Technology

"Reward" from Brain Stimulation in the Rat

The present work started with the observation that a rat with electrodes chronically implanted in the anterior-commissure region would return to the place in an open field where electric stimulation had been applied. The animal appeared either to be curious about the stimulus or to be attempting to get more. Acting on the latter possibility, a situation was arranged in which the animal could stimulate its own brain by pressing a bar.

Under these conditions, the animal did in fact stimulate itself regularly for long periods of time, and such stimulation is inferred to be rewarding. By implanting in a number of brain areas, it was found that most electrodes in the septal area, lateral amygdala, and anterior hypothalamus produce extreme reward. Most electrodes in the cingulate cortex and hippocampus produce mild reward. Other electrodes did not produce reward.

To find whether this cerebral "reward" would function in a way comparable to conventional rewards in less stereotyped situations, learning and performance have been tested in a runway and maze, with electric stimulation as the only incentive. When electrodes were placed in the basomedial forebrain, in the area of the nucleus of the diagonal band and the olfactory tubercle, animals ran the runway faster for stimulation than for food and produced learning curves in the maze comparable to those of a control group running for food.

JAMES OLDS
McGill University and
University of California, Los Angeles

Photoproduction of Neutral Pions from Protons at Forward Pion Angles

Low-energy recoil protons from the process $\gamma + p \rightarrow p + \pi^0$, detected by nuclear emulsions placed within the hydrogen gas target container, have been used to measure the differential cross section. The entering angle and range of protons stopping in a tilted C-2 600- μ emulsion are measured, and from these data the incident photon energy and pion angle can be

determined. In this manner protons of energies as low as 5 Mev can be detected at laboratory angles corresponding to emission of a pion at center-of-mass angles as low as 26°.

This experiment thus supplements that of R. L. Walker and D. C. Oakley [*Phys. Rev.* 97, 1283 (1955)] which covers the same range of photon energies (200 to 500 Mev) but is restricted to pion angles greater than about 70°, owing to higher minimum detectable proton energy. Common experimental points provide intercomparison of absolute values. The data at lower photon energies may also be compared with the results of the M.I.T. [Goldschmidt-Clermont, Osborne, and Scott, *Phys. Rev.* 97, 188 (1955)] and Illinois [L. J. Koester, *Phys. Rev.* 98, 211 (L) (1955)] groups. The effect of the present results on the angular distributions and total cross sections deduced from previous data is presented and discussed. In particular, the measurement in the forward hemisphere provides a sensitive check on the value of B in the angular distribution $A + B \cos \theta + C \cos^2 \theta$.

This research was supported by the U.S. Atomic Energy Commission.

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Cornell University

Double Crossing Over in *Neurospora*

It is known that a crossover involves exchange of material between only two of the four products of a meiosis. A knowledge of the strand relationships in multiple crossovers should be helpful in understanding the mechanics of the crossing-over process.

An ascospore mutant of *Neurospora crassa* has been used in this study. Crossing over in the region between the spore mutant locus and the centromere can be detected by the pattern of segregation for the spore character in the ascus. This feature makes it possible to avoid the labor of dissection and classification of those asci with no crossover in this region. Unfortunately, the spore mutant is nearly always lethal, so the two spore pairs in an ascus that carry it cannot be classified for other segregating mutants. This limits the amount of information obtainable, but it is still possible to detect the strand relationships of double crossovers in certain situations. In a study involving the interval from the ascospore mutant to the centromere (region A) and a marked region in the opposite arm of the same chromosome (region B), the two-strand and four-strand double crossovers and one of the two types of three-strand doubles are all detectably different from one another and from exchanges of lower rank.

Among 2928 asci there were 43 two-strand double crossovers, 54 of the detectable three-strand type, and 53 involving all four strands. This is consistent with the 1 : 1 : 1 ratio expected with random association of strands. One hundred ninety-eight asci with no crossing over in region

A gave a map distance of 16.7 units for region B. Among 610 asci with single crossovers in region A, the exchange rate in region B was 16.6 map units.

These results indicate that crossing-over events in one arm of a tetrad have no correlation with or influence on such events in the opposite arm. They fail to confirm the observation of Lindegren and Lindegren [*J. Heredity* 28, 105 (1937)] of a high coincidence of exchanges in the two chromosome arms with most of the double crossovers involving only two strands. The present findings are in good agreement with the recent study of Howe [*Records of the Genetics Society* (1954)], which showed no evidence of interference across the centromere.

DAVID R. STADLER
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Monthly Change of Diurnal Variation of Irregular Geomagnetic Fluctuations

A study of the diurnal variation of the irregular geomagnetic fluctuations in moderately low latitudes reported earlier [Nicholson and Wulf, *Science* 121, 626 (1955)] for the 7 years 1940-46 has been extended to the 9 years 1940-48. The eight daily K numbers (3-hour-range indices) for six observatories (see reference) fairly well distributed in longitude have been used in this work. An average local-time and an average universal-time diurnal variation have been formally obtained from these data.

The monthly change of the local-time diurnal variation seems to be due largely to an afternoon subsidiary maximum occurring principally around the June solstice. The monthly change of the universal-time diurnal variation suggests roughly opposite character of the variation about the equinoxes. There is, however, an appreciable yearly average variation. When this is deducted from the monthly values, the averages of these departures for the 4 months around the December solstice and around the June solstice are nearly mirror images of one another.

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California Institute of Technology

Determination of Crustal Structure from Local Variations of Phase Velocity of Rayleigh Waves

A method of deducing local changes in crustal structure from variations of phase velocity of Rayleigh waves is described. The method utilizes the prolonged, sinusoidal trains of dispersive Rayleigh waves characteristic of long oceanic propagation paths. Crests and troughs of these waves may be followed across a triangular array of seismograph stations when the station separations are not more than a few wavelengths. Phase velocity and direction of approach may be determined as a function of period.

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Preliminary results for Southern California indicate a reduction of phase velocity of about 10 percent for waves crossing the Sierra Nevada range. This may be interpreted as an effect of crustal thickening under the mountains to depths about 50 percent greater than under the coastal regions.

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The Born Approximation in Electron Diffraction

The electron diffraction study of the geometric structures of gas molecules is productive and comparatively simple, partly because a simple theory—the Born approximation—is available for interpreting the complex physical phenomenon. Many hundreds of structures have been studied by the method. However, a few dubious unsymmetrical structures were reported, and the essential experimental results were later confirmed, all for molecules made up of both light and heavy atoms and most notably for uranium hexafluoride. It has now been recognized that a characteristic failure of the Born approximation is involved, and progress has been made toward a more adequate theory [V. Schomaker and R. Glauber, *Nature* 170, 90 (1952); R. Glauber and V. Schomaker, *Phys. Rev.* 89, 667 (1953); J. A. Hoerni and J. A. Ibers, *Phys. Rev.* 91, 1182 (1953); J. A. Ibers and J. A. Hoerni, *Acta Cryst.* 7, 405 (1954)]. The present status of the work is reviewed.

VERNER SCHOMAKER
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Individual Variations of Productivity in Research Laboratories

The contribution that an individual makes to science is almost impossible to evaluate quantitatively, and no attempt is made to do so in this study.

Significant indications of variations in productivity between similar groups of individuals can be studied statistically, using rate of scientific publication as a measure of one aspect of scientific productivity. (Previous investigations have shown correlation between amount of publication and other indices of scientific productivity.) Within a particular research laboratory—for example, Brookhaven, Los Alamos, or the National Bureau of Standards—there are scientists who publish 100 times more prolifically than others; the statistics of these variations may be described by a relatively simple distribution law, which states that the logarithm of the rate of publication is distributed normally.

The relationship between salary and productivity has been investigated in such a way as to eliminate the general increase in salary with age by using four salary quartiles, each having the same age distribution, average salary increasing in three steps from quartile IV to quartile I.

Although there are large variations of rate of publication within each quartile, the average rate increases steadily, with quartile I being 3 to 10 times higher than quartile IV. A 30-percent to 50-percent increase in productivity corresponds to a 10-percent increase in salary, thus statistically much more output per dollar is obtained from the higher paid workers.

Generally, similar conclusions are reached by using either patent applications instead of publications or academic rank instead of salary. If it is assumed that, in addition to rate of publication, salary is determined by several other unknown, independent, and equally important factors, then the data can be best fitted by assuming that four factors altogether are involved.

WILLIAM SHOCKLEY
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Maximum Information Rate through a Human Channel in Reading

The matter of the limiting rate at which a person can utilize or produce information arises in connection with communication and control systems of which a human being forms a part. Licklider, Stevens, and Hayes at M.I.T., and Quastler and Wulff at the University of Illinois have found information rates for reading aloud lists of randomized words, for pointing, for reading and pointing, and for playing random music.

The present work explores reading aloud. The limitation in reading rate is not mechanical, for a person can repeat phrases or read prose considerably faster than he can read randomized word lists. Reading rate is strongly governed by familiarity; two-syllable familiar words are read faster than one-syllable unfamiliar words. The rate is initially constant as the number of alternative words is increased. The maximum rate achieved, with a set of 2500 familiar one-syllable words, was 40 bits a second (220 words a minute). This is as high as reported by Licklider *et al.* for reading and pointing. Estimates for information rate in reading prose are somewhat below this, although word rates may be more than 300 words per minute. Very high word rates reported for silent reading are presumably rates for skimming, not reading.

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Crystallization of Purified MEF-1 Polio Virus

Highly purified and concentrated MEF-1 polio virus was prepared from infected monkey kidney tissue culture fluid by chemical and physical procedures, the final steps of which included fractionation by electrophoresis and by sedimentation in a sucrose density gradient. The product was a single homogeneous component con-

sisting of spherical particles 27 mμ in diameter with which infectivity has been shown to be associated. Three-dimensional crystals of the virus particles formed during 24 hours at 4°C in an ultracentrifuged pellet of the purified virus concentrate covered with unbuffered isotonic saline at pH 5.9. They appeared to be bipyramidal tetragonal prisms and were approximately 30 μ long. Ultraviolet microscopy of the crystals gave a spectrum consistent with that of a nucleoprotein—that is, absorption below 295 mμ and no absorption above 300 mμ. The washed crystals were readily dissolved and the virus was recrystallized from buffered saline.

Specific infectivity measurements (expressed as plaque-forming units per milliliter of virus suspension of one optical density unit at 260 mμ) of the original purified virus concentrate and of the dissolved crystals and mother liquors from the first and second crystallizations were the same. The results indicate that the crystals were composed of polio virus particles. Although several plant viruses have been crystallized, the present work represents the first time an animal or human virus has been obtained in the form of crystals observable by light microscopy.

C. E. SCHWERTD

F. L. SCHAFFER

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Volume Changes on Mixing Nonpolar Liquids

According to the theory of "regular" solutions, two nonpolar liquids will expand on mixing, and the volume change observed should be proportional to the (positive) excess free energy usually observed for such systems. Newer approaches (Prigogine and coworkers, Salsburg and Kirkwood), based on the theory of corresponding states, predict, instead, contraction when two molecular species of nearly identical intrinsic size are mixed, even though the excess free energy is still positive.

Recently I have developed a new corresponding-states treatment of solutions that uses the experimentally observed equation of state of a reference liquid rather than the rather unrealistic theoretical models for liquids used by previous workers. When carbon tetrachloride is used as this reference liquid, one obtains equations:

$$\Delta F^E = \langle \Delta E^V \rangle [0.95(\eta^*)^2 + 1.67(\eta^* \xi^*) + 3.73(\xi^*)^2] x_1 x_2$$

$$\Delta V^E = \langle V \rangle [-0.03(\eta^*)^2 + 2.84(\eta^* \xi^*) + 3.27(\xi^*)^2] x_1 x_2$$

where $\langle \Delta E^V \rangle$ is the average energy of vaporization for the two liquids and $\langle V \rangle$ is the average of their molar volumes. The parameter η^* is proportional to the difference in the energies of vaporization; ξ^* , to the difference in volumes. Experimental measurements on solutions of nonpolar nonelectrolytes are in good qualitative agreement with these equations, although there are some notable exceptions.

The reason for the failure of the early

theories of volume change lies in their assumption that the entropy of mixing at constant volume is ideal. Two liquids with different energies of vaporization are necessarily at different reduced temperatures and consequently unequal degrees of expansion; the resulting solution is in an intermediate state, and small but significant entropy deviations result.

ROBERT L. SCOTT

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Unidirectional Progression of Faulting

An epicenter determined from seismograms represents the initial point of a rupture, which in a large earthquake may extend for many miles. In several well-observed instances, instrumental epicenters for foreshocks, main shock, and aftershocks can be correlated with field observation of the extent of faulting. Rupture is found to begin at one end of the active fault segment. Aftershocks scatter along this segment but show concentration near the two ends. Foreshocks occur close to the main shock epicenter, possibly outside the segment of principal rupture. Many less completely known major seismic events can be assigned to the same pattern.

In a few large earthquakes faulting may have extended in opposite directions from the initial point. The common erroneous impression that this is the rule (instead of the exception) is due to the obsolete practice of locating epicenters on a noninstrumental basis, at the center of figure of the isoseismals representing local intensities. The instrumentally determined epicenter is normally to one side of this center of figure. This is to be expected if energy is radiated strongly from the central part of the fault segment; also, since radiation is in effect from a moving source, there are increased amplitudes in the direction toward which the rupture progresses.

C. F. RICHTER

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Feasibility of High-Energy Photo-Meson Production Studies Using a Hydrogen Bubble Chamber

The feasibility and desirability of studying high-energy particle interactions using bubble chambers [D. A. Glaser, *Phys. Rev.* 97, 474 (1955)], and in particular liquid hydrogen bubble chambers, have been well established [H. C. Dittler and T. F. Gerecke, UCRL Rpt. 2985 (1955)]. However, it is not obvious that such equipment may be successfully employed in a bremsstrahlung photon beam for photo-production studies of π or K mesons, because of the relatively high background production from Compton scattering and pair production in the chamber.

With the generous assistance and cooperation of Luis Alvarez, J. D. Gow, and the University of California Radiation Laboratory bubble-chamber group, and of Robert Kenney of the UCRL synchrotron laboratory, a feasibility study was made

on the use of a hydrogen bubble chamber in such experiments. The UCRL 4-in. liquid hydrogen chamber was irradiated with 290 Mev photons from the UCRL electron synchrotron. Photographs were taken under varying beam conditions, both with and without the presence of a LiH beam "hardener" to absorb selectively low-energy photons in front of the chamber.

As was expected from preliminary calculations, it would appear impractical to perform meson production experiments with "unhardened" beams. However, with the background reduction resulting from the use of LiH, photo-production experiments involving total cross sections of 0.1 mb., and with improvements in technology considerably smaller cross sections would seem possible. Pi meson production experiments near threshold would appear to be very feasible, provided that the hydrogen temperature is maintained at a reduced value so that tracks of minimum ionization are "biased out."

JOHN M. TEEM

California Institute of Technology

Investigation of Nuclear Size by X-ray Fine-Structure Splitting in Heavy Atoms

Schawlow and Townes have shown that the $L_{II}-L_{III}$ x-ray level separation in heavy nuclei is affected to a slight extent by the finite extension of the nuclear charge distribution. This influence, their theory shows, increases rapidly in the high atomic number range depending exponentially on Z , the atomic number. Schawlow and Townes have shown on the basis of presently available x-ray data fairly clear-cut evidence for the existence of the effect. Even for plutonium, however, the effect is so small that extreme accuracy in the x-ray measurements is required if one is to improve on existing data sufficiently to get information on nuclear charge distribution comparable to that available by such methods as the high-energy electron scattering of Hofstadter and associates at Stanford or the mesonic x-ray data obtained at Columbia, Rochester, or Pittsburgh. Since the different methods disagree somewhat regarding the sizes of nuclear charge distributions, considerable interest attaches to the problem. The present paper describes x-ray measurements directed at obtaining more accurate data for this specific purpose.

This research was sponsored by the U.S. Atomic Energy Commission.

ROBERT L. SHACKLETT*

JESSE W. M. DUMOND

California Institute of Technology

* Present address: Fresno State College

Diameter of the Andromeda Nebula

In 1933 Stebbins and Whitford measured the Andromeda Nebula with a photoelectric cell on the 100-in. telescope at Mount Wilson and traced the light of the nebula outward considerably beyond the limits shown on photographs, proving that

the nebula was at least twice as wide as had been previously assumed. The present report deals with recent similar work with the 36-in. Crossley reflector of the Lick Observatory. Improvements of 20 years, including the introduction of an RCA antimony-cesium photomultiplier in place of the former Kunz potassium cell and the substitution of a recording potentiometer for a visually read galvanometer, have made the sensitivity of the installation on the Crossley even better than that used on the 100-in. with its eightfold greater light-gathering power. For instance, the light and color of one or two of the brightest globular clusters in Andromeda were measured with difficulty with the 100-in., but recently Kron and Mayall have observed several score of these objects with the Crossley, most of them fainter than the former limit of the 100-in.

A series of continuous traces across the nebula, giving its intensity freed from the foreground of galactic stars, confirms the dimensions previously found, and the new study is being made in two or more colors. Each expansion of the measured dimensions of the nebula makes it a system more nearly comparable in size with our own galaxy.

JOEL STEBBINS
GERALD E. KRON

Lick Observatory

Energy Loss of Protons in Metals

The rate at which protons lose energy in passing through thin evaporated layers of metal has been measured for protons in the energy range between 50 and 600 kev. The materials studied are Li, Be, Al, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Au, and Pb. Together with earlier measurements in this laboratory of the rate of energy loss in several gases, these results provide information about the variation of energy loss with the atomic number of the stopping material.

For high-energy protons, the energy loss per stopping atom increases smoothly with Z ; the scattered results that are available are consistent with the theoretical $Z^{1/2}$ dependence. For protons of low energy, below 100 kev, marked departures from this dependence were observed in this experiment; for example, the stopping cross section of argon is greater than that of gold for $E_p < 100$ kev. The influence of molecular binding on the stopping cross section of compounds becomes noticeable below 150 kev. For protons of 500 kev, a fairly uniform Z dependence is apparent over most of the periodic table, but two types of deviation are still observed. First, the stopping cross sections of the noble gases are relatively lower than those of their neighbors. This effect can be understood in terms of the reduced energy loss to the more tightly bound electrons of closed shells. Second, in the region from $Z=23$ to 29, the stopping cross section decreases with increasing Z . With the exception of a high value at Cr, the decrease is fairly uniform from V through Cu. Although stopping cross-section measurements are not available for the rare earths, the values

for Xe and Au indicate that a similar decrease may occur in this region.

This research was assisted by the joint program of the U.S. Office of Naval Research and the Atomic Energy Commission.

WARD WHALING
R. E. PIXLEY

California Institute of Technology

Dislocations and the Yield Point in Steel

The theory of dislocations in metal crystals is employed to describe the mechanism of the initiation of plastic yielding in low-carbon steel. Dislocations are generated at Frank-Read sources when stress is applied to the material. The rate of generation is governed by the thermally activated release of the source dislocation from a Cottrell "atmosphere" of carbon and nitrogen atoms.

The first dislocation generated at a given source expands rapidly outward until it is stopped by the grain boundary. Succeeding dislocations come to rest at equilibrium positions in the slip plane between the source and grain boundary. The local shear stress at the grain boundary increases in proportion to the number of dislocations. When a critical value of this stress is reached, slip propagates across the boundary into adjacent grains, thus initiating the abrupt and discontinuous yielding that is characteristic of low-carbon steel.

Experimental observations of the time and temperature dependence of the initiation of yielding are correlated with the dislocation mechanism described. These observations include the delay time for the initiation of yielding under constant applied stress and the preyield microstrains that take place during the "delay time."

DAVID S. WOOD

California Institute of Technology

Inhibition of Cell Division in Sea Urchin Eggs by Specific Antisera

Rabbits were immunized with various constituents of eggs and sperm of sea urchins, and the antisera were studied for specific effects on development of the eggs. During these investigations it was observed that certain antisera blocked cleavage of the eggs very effectively. Nuclear, as well as cytoplasmic, division was inhibited. The time for mitotic block in strong antisera was less than the period of one division. Antisera against extracts of unfertilized, as well as of fertilized, eggs were effective, but those prepared against whole sperm or specific extracts (for example, antifertilizin) thereof were not. Absorption with sperm did not remove the blocking action. Of special interest was the finding that antisera prepared against purified fertilizin possessed the antimitotic action. Since fertilizin constitutes the gelatinous coat and surface of the unfertilized egg, and this is removed from the fertilized eggs on which the tests are made, the new surface is evidently

antigenically related to fertilizin. The blocking action could be overcome by treating the antisera with an excess of fertilizin.

A marked temporary rise in respiratory rate occurs in fertilized eggs treated with antimitotic antisera. Determination of sodium content inside the treated eggs showed no significant increase. The tension at the surface of the egg increased greatly upon antiserum-treatment. Cytolysis occurs in the blocking antisera after several hours' exposure. Treatments as short as 15 to 30 minutes in strong antiserum suffice to block cell division irreversibly. Heating the antisera at 56°C for 1 hour, to inactivate complement, does not destroy the antimitotic action.

ALBERT TYLER
JOHN W. BROOKBANK

California Institute of Technology

Substitution Reactions of Aromatic Halides

Previous research [J. D. Roberts *et al.*, *J. Am. Chem. Soc.* 75, 3290 (1953); J. D. Roberts *et al.*, *ibid.*, in press] has demonstrated that the conversion of phenyl halides to aniline by potassium or sodium amide in liquid ammonia involves an elimination-addition mechanism probably by way of an electrically neutral entity of composition C_6H_5 , "benzyne." It has now been found that mixtures of toluidines result from the amination of the individual halotoluene isomers. These mixtures have compositions that are at least consistent with operation of the elimination-addition mechanism and the expected electric effect of aromatic methyl groups.

A parallel study of rearrangements in high-temperature hydrolyses of halotoluenes has revealed that the extent of rearrangement is a rather sensitive function of temperature, alkali concentration, and the nature of the halogen. It is concluded that high-temperature hydrolyses of aryl halides may involve either elimination-addition or halide-ionization mechanisms, the latter being favored with the more easily ionizable halogens at low alkali concentrations. By suitable choice of conditions, one or the other reaction may be made to occur almost exclusively.

JOHN D. ROBERTS
A. T. BOTTINI
D. A. SEMENOV

California Institute of Technology

Problem of Beta Lyrae

Beta Lyrae is a naked-eye eclipsing double star, whose period of nearly 13 days has steadily increased since its discovery, at an average rate of the order of 9.4 sec/yr (Z. Kopal). This large increase must be due to a rapid evolutionary change in the binary system. This paper attempts to elucidate this change. A series of 195 high-dispersion spectrograms of Beta Lyrae obtained with the 100-in. telescope at Mount Wilson leads to a model for study. Both components of the

binary are unstable, presumably because they have individually grown in size, as a consequence of nuclear processes in their interiors, until they are now spilling over the critical surface of zero velocity, which is characterized by the common, inner Lagrangian point, L_1 . Both supergiant components lose mass from their inner extremities, in the form of two violent currents or streams of gas, which gradually dissolve in a disk-shaped expanding nebulosity that ultimately escapes into interstellar space.

The effect of the streams is, as S. S. Huang has recently shown, to increase the period and the orbital radius. A rough estimate, by Huang, of the loss of mass required to produce the observed increase in the period is 3×10^{28} g/sec, if the mass of the B9 component is $52 \odot$. The total area from which the two streams emerge is of the order of 10^{26} cm². Hence, each square centimeter ejects, theoretically, 10^{-8} g/sec, or 10^{21} atoms/sec, mostly of ionized hydrogen. At certain phases we observe the streams moving with a velocity of about 200 km/sec, through a depth of about 2×10^6 km. The entire amount of material producing a violet-displaced absorption line was, therefore, ejected in 10^4 sec. The resulting number of atoms in the entire stream is, thus, 10^{25} cm³—an amount that is not inconsistent with the observed equivalent widths of the absorption lines, especially in view of the fact that the ionization of hydrogen in the stream must be very large.

The total mass of the heavier component (B9) of the Beta Lyrae may be about 50 times that of the sun or, roughly, 10^{30} g. Hence, at its present rate of dissipation it would exhaust most of its substance in 3×10^{13} sec, or 100,000 years.

OTTO STRUVE
JORGE SAHADE

University of California, Berkeley

Use of Multiple Spectrograph Slits in the Study of Internal Motions of Gaseous Nebulae

The bright planetary nebulae are all relatively small objects with diameters of the order of 10 to 20 sec of arc. Radial velocities of the nebular material may be obtained by placing the telescopic image of a nebula on the slit of a spectrograph and photographing the resulting spectrum.

A spectrograph with a single slit provides kinematic information only along the narrow strip of the nebula where the slit crosses the image. Since the exposure times are rather long, it would be time-consuming, as well as extremely difficult, to map accurately the kinematic relationships across a nebula by means of a series of single-slit exposures.

The problem is readily solved by using simultaneously a number of closely spaced parallel slits on which the nebular image is centered. In this manner it is possible, for the same expenditure of telescope time required for a single-slit exposure, to obtain a kinematic picture of the entire object.

Such multislit, ruled on an aluminized piece of glass, have been constructed for both the 100-in. and 200-in. telescopes and have provided much instructive data on the internal motions of the planetaries. At Palomar a multislit is currently being used to investigate the detailed internal motions of the Orion Nebula.

O. C. WILSON

Mount Wilson and Palomar Observatories

New Books

Handbook of Hydrocarbons. S. W. Ferris. Academic Press, New York, 1955. 324 pp. \$8.50.

Handbuch der Pflanzen-Züchtung. Band 1, *Grundlagen der Züchtung: Lieferung 1, Biologisch-genetisch und Physiologische Grundlagen der Züchtung.* Hans Kappert and Wilhelm Rudolf, Eds. Paul Parey, Berlin, ed. 2, 1955 (to be published in 6 vols., comprising approximately 38 issues). 80 pp. DM. 13.50 per vol.

The Construction of Laboratory Apparatus for Schools. Workshop designs with specifications and instructions. Ser. II, *Secondary* (in French and English). Prepared for UNESCO by H. Struers Chemiske Laboratorium, Copenhagen, Denmark. UNESCO, Paris, 1955 (order from Columbia Univ. Press, New York). Portfolio and 76 plates. \$8.

Genetics Notes. James F. Crow. Burgess, Minneapolis 15, ed. 2, 1955. 124 pp. \$2.50.

Annual Review of Physical Chemistry. vol. 6. G. K. Rollefson, Ed. Annual Reviews, Stanford, Calif., 1955. 515 pp. \$7.

The Physiology of Diapause in Arthropods. Cambridge Monogr. in Experimental Biology No. 4. A.D. Lees. Cambridge Univ. Press, New York, 1955. 151 pp. \$2.50.

Erlebtes aus der Thoraxchirurgie. Rudolf Nissen. Thieme, Stuttgart, 1955 (Order from Intercontinental Medical Books, New York 16). 65 pp. \$3.40.

Amateur Astronomer's Handbook. J. B. Sidgwick. Macmillan, New York, 1955. 580 pp. \$12.50.

Advances in Cancer Research. vol. III. Jesse P. Greenstein and Alexander Haddow. Academic Press, New York, 1955. 369 pp. \$8.50.

Cancer Cells. E. V. Cowdry. Saunders, Philadelphia, Pa., 1955. 677 pp. \$16.

Gas Kinetics. An introduction to the kinetics of homogeneous gas reactions. A. F. Trotman-Dickenson. Academic Press, New York; Butterworths, London, 1955. 322 pp. \$8.

Instruments for Measurement and Control. Werner G. Holzbock. Reinhold, New York; Chapman & Hall, London, 1955. 371 pp. \$10.

Man's Nature and Nature's Man. The ecology of human communities. Lee R. Dice. Univ. of Michigan Press, Ann Arbor, 1955. 329 pp. \$5.

Man's Emerging Mind. Man's progress through time—trees, ice, flood, atoms and the universe. N. J. Berrill. Dodd, Mead, New York, 1955. 308 pp. \$4.

Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, but to the publisher or agency sponsoring the publication.)

Natural Availability of Oak Wilt Inocula. Bulletin of the Illinois Natural History Survey, vol. 26, No. 3. E. A. Curl. 26 pp.

Joint FAO/WHO Expert Committee on Nutrition. Fourth report. WHO Tech. Rpt. Ser. No. 97. World Health Organization, Geneva, 1955 (Order from Columbia Univ. Press, International Documents Service, 2960 Broadway, New York 27). 58 pp. \$0.60.

Oil and Gas Pipe Lines in Ohio. A map. Compiled by Robert L. Alkire. Ohio, Department of Natural Resources, Columbus, rev. ed., 1955. \$1.50.

Some Polyclad Flatworms from Polynesia and Micronesia. Proceedings of the United States National Museum, vol. 105, No. 3352. Libbie H. Hyman. The Museum, Washington, 1955. 17 pp.

Geology of Olympic National Park. Wilbert R. Danner. Univ. of Washington Press, Seattle, 1955. 68 pp. \$1.25.

Annual Report, 1954. Harvard Astronomical Observatory. The University, Cambridge, Mass., 1954. 42 pp.

Methods of Detecting and Tracing the Movement of Ground Water. Annual Progress Rpt. No. 1, Canal Seepage Research. Warren J. Kaufman and David K. Todd. Sanitary Engineering Research Lab., Univ. of California, Berkeley, 1955. 130 pp.

Summary of Survey of Philanthropic Foundation (Excerpted from *American Foundations and Their Fields*, 7th ed.). Wilmer Shields Rich. American Foundations Information Service, New York 3, 1955. 32 pp. Single copy free.

Science in Alaska, 1952. Proceedings of the Third Alaskan Science Conference, Alaska Division, AAAS, held at Mt. McKinley National Park, 22-27 Sept. 1952. Alaska Division, AAAS, College, Alaska, 1954. 221 pp. \$3.

Report of the University Museums, 1953-1954. Univ. of Michigan, Ann Arbor, 1955. 28 pp.

Annual Report of the Dean, 1954. Harvard School of Public Health. Harvard Univ., Cambridge, Mass., 1955. 243 pp.

Toxicity to Greenhouse Roses from Paints Containing Mercury Fungicides. Bull. 595. A. E. Dimond and E. M. Stoddard. Connecticut Agricultural Experiment Sta., New Haven, 1955. 19 pp.

The C.S.I.R.O. Poultry Research Centre. Tech. Paper No. 1, Div. of Animal Health and Production. F. Skaller. 19 pp. *Common Names of Insects and Allied Forms Occurring in Australia.* Bull. No. 275. Compiled under the direction of F. J. Gay. 32 pp. Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia, 1955.

Baltimore and the H-Bomb. Vol. 9, No. 2. Studies in business and economics. Bur. of Business and Economic Research, Univ. of Maryland, College Park, 1955. 16 pp.

A Survey of Atomic Constants. J. A. Bearden and John S. Thomsen. Johns Hopkins Univ., Baltimore, Md., 1955. 138 pp.

Scientific Meetings

Role of Physical Anthropology in the Field of Human Identification

On 6-9 Sept. 1955, in Washington, a group of physical anthropologists assembled, probably for the first time in the history of their science, to discuss with others the subject used as the title of this brief report. The "others" included representatives of the Federal Bureau of Investigation, the Armed Forces, the U.S. Public Health Service, and the Offices of the Maryland and Virginia Medical Examiners. In addition, T. C. Brown of Toronto, Canada, brought experience obtained through service on the Medical Identification Commission for the *Noronic* disaster, and Walter C. J. Putschar of Charleston, W. Va., brought experience in bone anatomy and histology developed in Europe.

At a get-acquainted dinner for the participants held on the evening of 6 Sept. at the Cosmos Club, T. D. Stewart (U.S. National Museum) gave a keynote account of anthropological participation in medicolegal matters. He emphasized that the problems of reconstructing the characteristics of the individual from bony and other remains have always been at the core of traditional anthropological activity, standing apart from the early side interests of the science, such as criminal anthropology—how criminals differ from normal persons—and anthropometric systems of criminal identification—how criminals are recognized by combinations of measurements, photographs, fingerprints, and so forth. He pointed out also that, although anthropologists have long been interested in fingerprints and blood groups, and these are largely responsible for direct individual identifications, the procedures involved are now standardized. He felt that greatest profit would result from consideration of class identifications, which relate a human being, or parts of the body, to classes such as race, sex, and age.

The main program consisted of five half-day panel discussions. The chairman of each panel had been charged to direct the discussion toward an evaluation of presently available knowledge and thus to clarify specific needs in the field. Although the panelists had been chosen

with care to give a broad coverage of the particular topics, the entire group of 60 participants was so well informed that inevitably discussion became general, with the panel serving mainly as a "front." Only a few highlights of the discussion can be mentioned here.

The first panel, led by W. M. Krogman (University of Pennsylvania), consisted of Harold L. Beddoe (Office of the Medical Examiner, Richmond, Va.), T. C. Brown, P. G. Duncan (FBI), and Joseph Nahan (Quartermaster School, Fort Lee, Va.). Their topic was "Physical anthropologists as specialists in human identification." In this connection a point of considerable concern to the anthropologists and those they serve is the fact that several identification standards are in existence. For example, age standards vary for single events in skeletal ossification, and the range of variation for the time that these events occur is not well established. This means that two anthropologists may differ in their opinions on the age of a skeleton. Differences of this sort sometimes prove embarrassing. It was suggested that work be directed toward a better way of expressing the probability of correctness in all such determinations and that cooperating agencies be made aware of the bounds of "precision" in identification.

The discussion of the second subject, "Identification of small remnants of the human body," was led by William S. Laughlin (University of Wisconsin) and his panelists, David Johnson (U.S. National Museum), Walter C. J. Putschar, David B. Scott (National Institute of Dental Research), and Briggs J. White (FBI). Of major concern was the development of methods of identifying bone, tooth enamel, and other tissues lacking in recognizable gross morphology. For example, even after the detailed configurations of the ridges and sulci of the skin have been destroyed, fingerprints may be developed from microscopic sections showing the arrangement of the ducts of the sweat glands. Suggested, among other things, as promising for further study in differentiating human and animal bones was a comparison of bone fats and of bone collagens. Evidence was presented that burned bones bear

witness to whether or not the heat had been applied when they were flesh covered.

The third panel began to consider specific determinations that can be made on the skeleton as a whole or its larger parts. A discussion of "Sex and age" was led by T. D. Stewart with the support of J. Lawrence Angel (Jefferson Medical College), W. Montague Cobb (Howard University), Frederic N. Silverman (Children's Hospital, Cincinnati), and Fred P. Thieme (University of Michigan). In determining sex from the skeleton, the role of function was discussed at length. Next, Thieme demonstrated the application of the principle of discriminant function in sex identification. By utilizing seven skeletal characters, he showed that sex may be determined in 98 percent of cases. The errors resulting from this sorting method were found usually to be females with male characters. Among the points developed regarding age estimation from the skeleton was the greater reliability of tooth calcification as compared with ossification of the wrist bones.

The fourth panel continued with "Reconstruction of stature, body build, and facial features." On this panel were William S. Cornwell (Eastman Kodak Company), C. Wesley Dupertuis (Western Reserve University), Russell W. Newman (Quartermaster Research and Development Command), and C. T. Noll (Memorial Division, Office of the Quartermaster General), with Mildred Trotter (Washington University School of Medicine, St. Louis) as chairman. Further improvement in the estimation of stature from lengths of long bones was shown to depend on analyses of body types. On the other hand, estimation of body weight from bones was shown to be useful primarily for lean body mass. As for facial reconstructions, Krogman presented a new technique based on the concept of the "ideal face" as developed from orthodontic stereographs. Also, the panel discussed the question of using existing x-rays of such parts as the frontal air sinuses or the jaws for individual identification (like fingerprints, high in reliability), together with the need for caution against exposure to unnecessary irradiation and for uniformity of technical factors.

The fifth and last panel, led by T. D. McCown (University of California), returned to a general subject, "Educational and administrative aspects." This panel consisted of Edward E. Hunt, Jr. (Forsyth Dental Infirmary, Boston), Charles E. Snow (University of Kentucky), William L. Straus, Jr. (Johns Hopkins University), and Thomas Toy (Memorial Affairs Branch, Wright-Patterson Air Force Base, Ohio). Since identification

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per se is not a part of the anthropological curriculum, attention was given to the best way of teaching the subject so that graduates may qualify as experts. The general feeling was that special training should be superimposed on a foundation of general physical anthropology and human anatomy. This led naturally to a discussion of the role of physical anthropologists in the military reburial program and to the continuing need for these specialists. The small size of the profession and the lack of specific training offered in identification were believed to account for existent inadequacies.

Although these few highlights give only a sketchy picture of the many ideas presented during the meeting, in general the discussion served to reorient the thinking of the physical anthropologists on the subject of identification. Like most scientists, they have been accustomed to working from the known toward general principles. If they have assumed too often that these general principles can be applied readily to the identification of an unknown individual, whatever disillusionment the discussion produced should be salutary. Also, it is likely that from now on certain researches in physical anthropology will be carried out with a view to direct application in identification work.

This meeting was the Eighth Summer Seminar in Physical Anthropology. All eight seminars have been held since 1946 and have been financed by grants from the Wenner-Gren Foundation for Anthropological Research, Inc. This year the Smithsonian Institution served as sponsor, with the undersigned acting as organizers.

T. D. STEWART
MILDRED TROTTER

Meeting Notes

■ Representatives of U.S. industrial firms interested in manufacturing boral sheets, an unclassified shielding material used in atomic energy operations, were invited by the Atomic Energy Commission to attend a meeting in Oak Ridge, Tenn., on 28 Oct. The purpose of the meeting was to encourage establishment of an industrial source of supply of these sheets, which are now being made only at the AEC facility in Oak Ridge. The AEC wishes to stop manufacture at Oak Ridge if industrial sources can be developed to supply the material on suitable terms.

Boral is a material for the absorption of thermal neutrons. It is a mixture of boron carbide and aluminum that is light in weight and has good heat conductivity and thermal stability up to the melting point of aluminum. It may be

used when a large thermal neutron flux must be absorbed without production of high-energy gamma rays, as in the inner sections of reactor shields, shutters of thermal columns, and in instruments.

■ The International Atomic Exposition, which will be held 10-16 Dec. in the Cleveland Public Auditorium in conjunction with the Nuclear Science and Engineering Congress, has opened offices in Cleveland at 507 Newman-Stern Building. F. Pat O'Toole is in charge of the Cleveland office, where he will facilitate coordination of activities.

■ The third Interamerican Congress of Psychology, which will take place at the University of Texas, Austin, 16-21 Dec., has as a central theme, "The psychology of social tension from an interdisciplinary point of view." The third congress will emphasize unification, integration, and action. Four symposia are planned that will consider the psychology of social tension from the psychological, social-anthropological, psychiatric, and educational points of view. For information write to the secretary, Werner Wolff, Bard College, Annandale-on-Hudson, N.Y.

■ Some 30 eye physicians of the United States are preparing to take part in the program of the fifth Pan American Congress of Ophthalmology, and several hundred others are expected to attend the meeting, which is to take place in Santiago, Chile, 9-14 Jan. 1956. Moacyr E. Alvaro of São Paulo, Brazil, is the present president of the association; C. Espildora Luque of Santiago will preside at the congress.

Twelve symposia on major causes of blindness and impaired vision will make up the program. Half the presiding chairmen will be from the United States; the remainder from Mexico, Central America, and South America. Canada will also be represented. In most of the groups the speakers are similarly divided.

Glaucoma will be the subject of three symposia. Peter Kronfeld of Chicago, Ill., will be the moderator of a comprehensive discussion of the disease; A. Edward Maumenee of Baltimore, Md., will lead a discussion of infantile glaucoma; and Jorge Valdeavellano of Lima, Peru, will preside over a group that will consider glaucoma in relation to systemic diseases such as diabetes. Other subjects include: methods of repairing a torn retina; tumors within the eye; mental and emotional difficulties that influence eye diseases; and plastic surgery to restore damaged eyes.

Besides the technical medical program, the congress will give attention to long-range methods of preventing blindness. The standing committee, of which Magin

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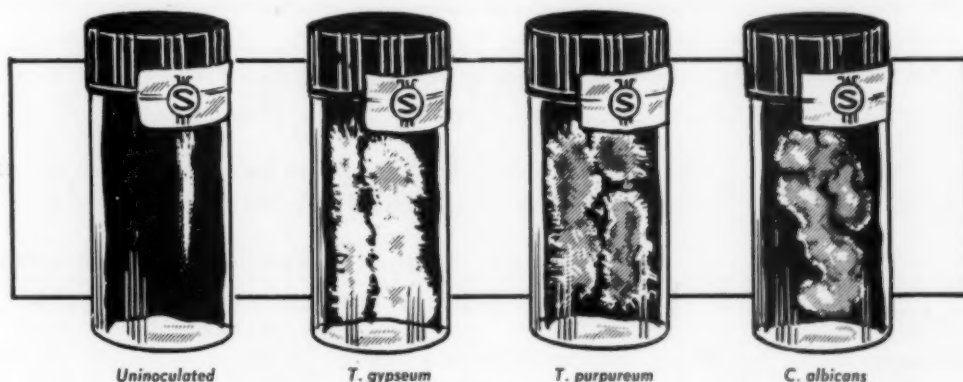
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■ Plans are being made for the first European symposium on Vitamin B₁₂, to be held the last week of May 1956 in Hamburg, Germany. The meeting will be under the auspices of the physiological chemist Kühnau and the internist Jores. The physiology and the clinical application of vitamin B₁₂ in human and veterinary medicine will be discussed. For information write to Dr. H. Bauer, Nervenlinik, Hamburg-Eppendorf, Germany.

Society Elections

■ Instrument Society of America: pres., Robert T. Sheen, Milton Roy Company, Philadelphia, Pa.; past pres., Warren H. Brand, Conoflow Corporation; sec., William G. Brombacher, National Bureau of Standards; treas., J. T. Vollbrecht, Energy Control Company. The vice presidents are A. A. Anderson, Swisso-

matic Products Company; William H. Fortney, Humble Oil Company; J. Ward Percy, U.S. Steel Corporation; and Richard N. Pond, Taylor Instrument Company.

■ American Society for Metals: pres., A. O. Schaefer, Midvale Company, Philadelphia, Pa.; past pres., George A. Roberts, Vanadium Alloys Steel Company, Latrobe, Pa.; v. pres., D. S. Clark, California Institute of Technology; sec., W. H. Eisenman, ASM, 7301 Euclid Ave., Cleveland 3, Ohio; treas., C. H. Lorig, Battelle Memorial Institute, Columbus, Ohio.

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■ American Psychological Association, Inc.: pres., Theodore M. Newcomb, University of Michigan; pres.-elect, Lee J. Cronbach, University of Illinois; past

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■ American Society for Horticultural Science: pres., M. B. Davis, Carp, Ontario, Canada; v. pres., L. D. Davis, University of California, Davis; sec.-treas., Freeman S. Howlett, Wooster, Ohio. Representatives to the AAAS Council are Irvin C. Haut, University of Maryland, and J. R. Magness, U.S. Horticulture Station, Beltsville, Md.

Forthcoming Events

December

4. American Acad. of Dental Medicine, 10th mid-annual, New York, N.Y. (G. J. Witkin, 45 South Broadway, Yonkers 2, N.Y.)

5-9. Combustion Colloquium, 2nd, Liege, Belgium. (2nd Combustion Colloquium, Univ. of Liege, Liege.)

8-10. Concept of Development, Minneapolis, Minn. (D. B. Harris, Inst. of

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Child Welfare, Univ. of Minnesota, Minneapolis 14.)

8-10. Florida Acad. of Sciences, Miami. (R. A. Edwards, Geology Dept., Univ. of Florida, Gainesville.)

9-10. Assoc. for Research in Nervous and Mental Disease, 35th annual, New York, N.Y. (C. C. Hare, 710 W. 168 St., New York 32.)

9-10. Texas Acad. of Science, annual, Waco. (G. P. Parker, P.O. Box 7488, College Station, Texas.)

9-13. American Acad. of Optometry, Chicago, Ill. (C. C. Koch, 1502 Foshay Tower, Minneapolis 2, Minn.)

10-16. Nuclear Cong. and Atomic Exposition, Cleveland, Ohio. (A. F. Denham, 931 Book Bldg., Detroit 26, Mich.)

10-16. Radiological Soc. of North America, Inc., Chicago, Ill. (D. S. Childs, Sr., 713 East Genesee St., Syracuse 2, N.Y.)

11-14. American Soc. of Agricultural Engineers, Chicago, Ill. (F. B. Lanham, ASAE, St. Joseph, Mich.)

11-14. American Soc. of Refrigerating Engineers, New York, N.Y. (R. C. Cross, ASRE, 234 Fifth Ave., New York 1.)

14. Operations Research Symposium, Philadelphia, Pa. (R. V. D. Campbell, Operations Research Symposium Registration, Burroughs Research Center, Paoli, Pa.)

15-17. Acoustical Soc. of America, Providence, R.I. (W. Waterfall, ASA, 57 E. 55 St., New York 22.)

15-17. International Union of Scientific Radio, U.S. national, Gainesville, Fla. (J. P. Hagen, Code 7100, URSI, Naval Research Lab., Washington 25.)

16-21. Interamerican Cong. of Psychology, 3rd, Austin, Tex. (W. Holtzman, Univ. of Texas, Austin.)

26-29. Biometric Soc., Eastern N. American Region, New York, N.Y. (A. M. Dutton, Box 287, Station 3, Rochester 20, N.Y.)

26-31. American Assoc. for the Advancement of Science, Atlanta, Ga. (R. L. Taylor, AAAS, 1025 Connecticut Ave., NW, Washington 6.)

27-29. American Mathematical Soc., 62nd annual, Houston, Tex. (J. H. Curtiss, AMS, 80 Waterman St., Providence 6, R.I.)

27-29. Archaeological Inst. of America, Chicago, Ill. (C. Boulter, 608, Univ. of Cincinnati Library, Cincinnati 21, Ohio.)

27-29. Assoc. for Symbolic Logic, Rochester, N.Y. (J. Barlaz, Rutgers Univ., New Brunswick, N.J.)

27-29. Linguistic Soc. of America, Chicago, Ill. (A. A. Hill, 1719 Massachusetts Ave., NW, Washington 6.)

27-29. Western Soc. of Naturalists, Davis, Calif. (D. Davenport, Univ. of California, Santa Barbara.)

27-30. American Statistical Assoc., New York, N.Y. (E. M. Bisgöyer, 1757 K St., NW, Washington 6.)

27-30. Inst. of Mathematical Statistics, New York, N.Y. (K. J. Arnold, Dept. of

Mathematics, Michigan State Univ., East Lansing.)

27-1. Phi Delta Kappa, 50th anniversary, Bloomington, Ind. (J. C. Whinnery, 324 N. Greenwood Ave., Montebello, Calif.)

28-29. Northwest Scientific Assoc., Spokane, Wash. (F. J. Schadegg, Eastern Washington College of Education, Cheney.)

28-30. American Economic Assoc., New York, N.Y. (J. W. Bell, Northwestern Univ., Evanston, Ill.)

28-30. American Historical Assoc., Washington, D.C. (B. C. Shafer, Study Room 274, Library of Congress Annex, Washington 25.)

28-30. American Philological Assoc., Chicago, Ill. (J. P. MacKendrick, Bascom Hall, Univ. of Wisconsin, Madison 6.)

28-30. Low Temperature Physics and Chemistry, Baton Rouge, La. (J. G. Daut, Dept. of Physics, Ohio State Univ., Columbus 10.)

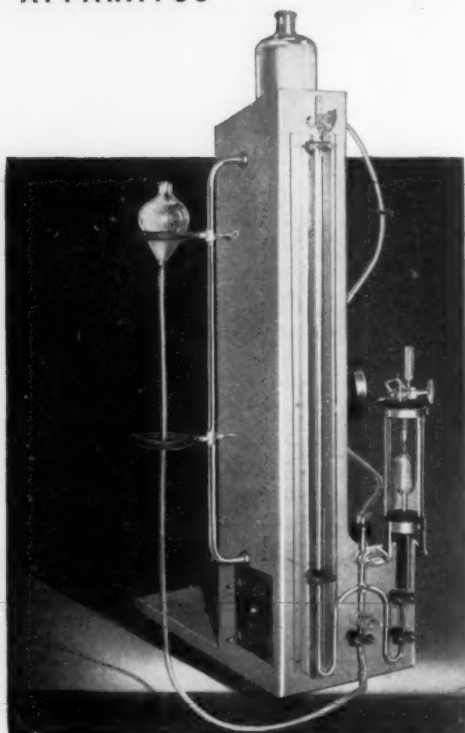
28-30. American Philosophical Assoc., Eastern Div., Boston, Mass. (W. H. Hay, Dept. of Philosophy, Univ. of Wisconsin, Madison.)

28-30. American Physical Soc., winter meeting, Los Angeles, Calif. (K. K. Darrow, Columbia University, New York 27.)

28-30. Econometric Soc., New York, N.Y. (R. Ruggles, Box 1264, Yale Station, Yale Univ., New Haven, Conn.)

(See 21 Oct. issue for comprehensive list)

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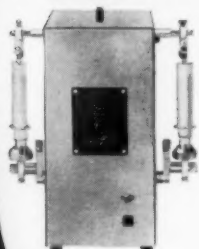
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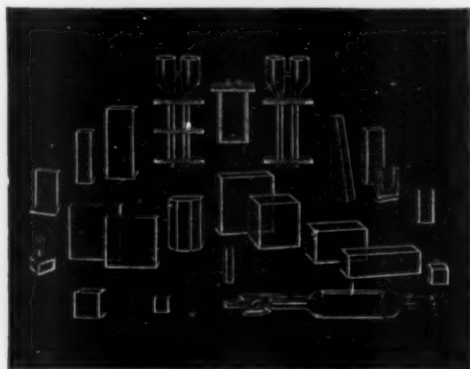
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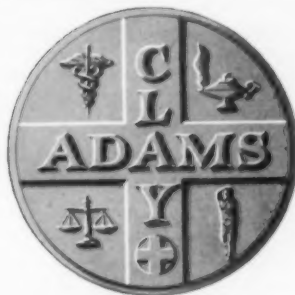
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Atlanta, Ga., December 26-31, 1955

The list of hotels and their rates and the reservation coupon below are for your convenience in making your hotel room reservation in Atlanta. Please send your application, *not* to any hotel directly, but to the AAAS Housing Bureau in Atlanta and thereby avoid delay and confusion. The experienced Housing Bureau will make assignments promptly; a confirmation will be sent you in two weeks or less. **As in any city, single-bedded rooms may become scarce; double rooms for single occupancy cost more; if possible, share a twin-bedded room with a colleague—and also save money.** Mail your application *now* to secure your first choice of desired accommodations. All requests for reservations must give a definite date and estimated hour of arrival, and also probable date of departure.

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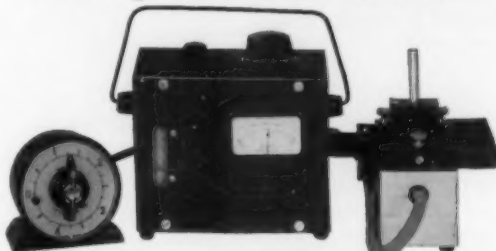
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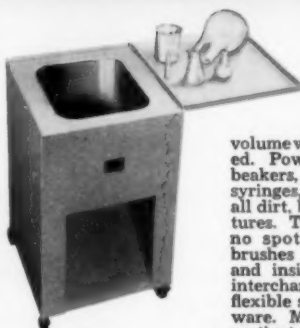
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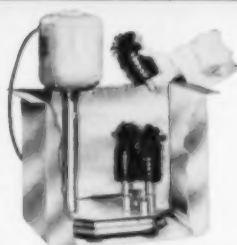
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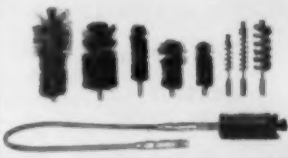
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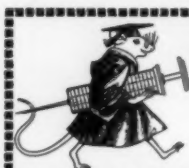
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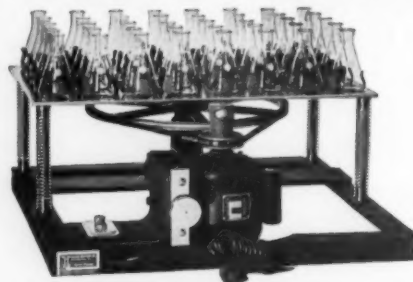
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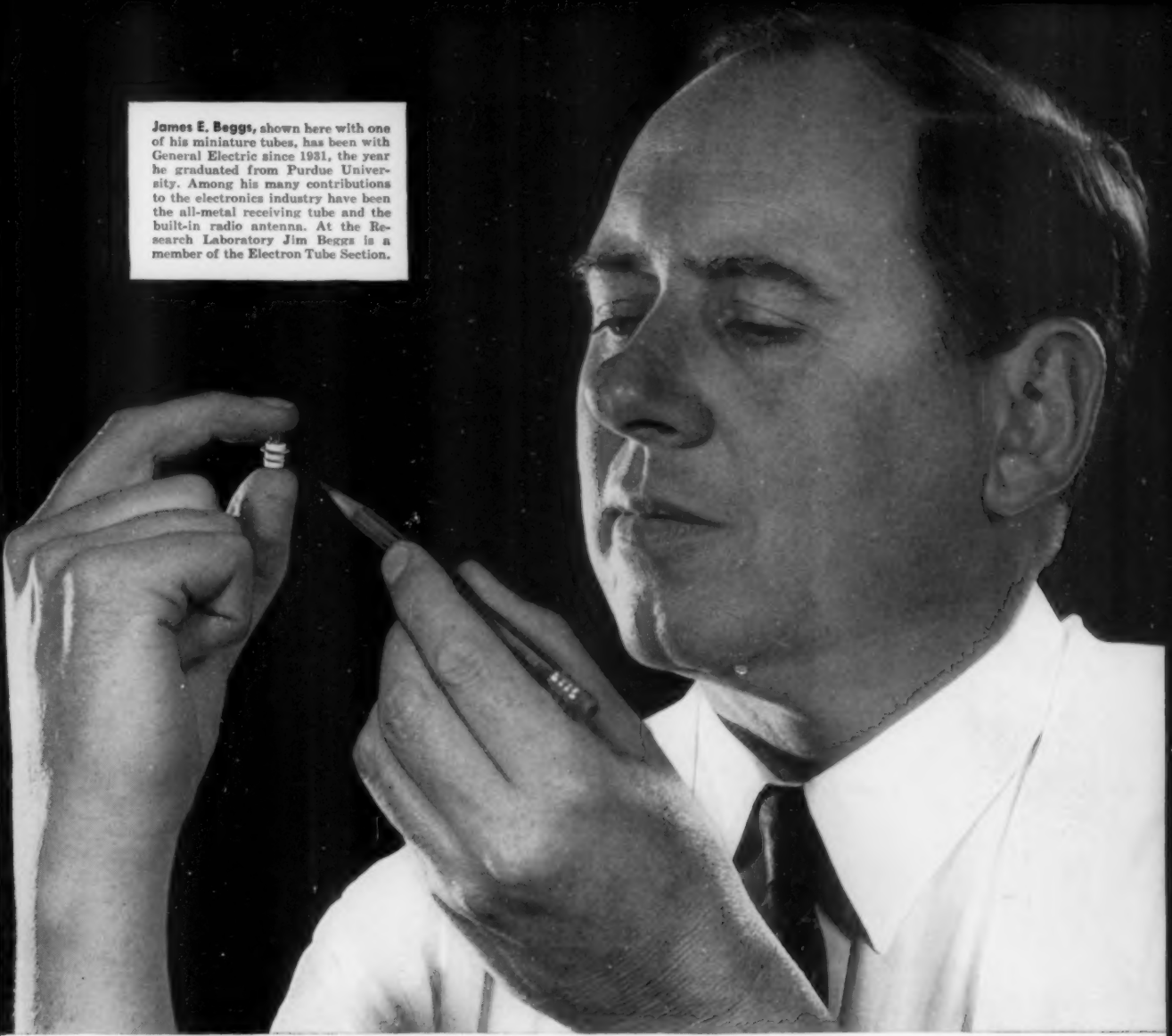
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